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North Central Forest Experiment Station

Research Paper **NC-264**

Forest Management Opportunities for Michigan, 1981-1990

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1992 Folwell Avenue
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Manuscript approved for publication June 17, 1985
1985

FOREST MANAGEMENT OPPORTUNITIES FOR MICHIGAN, 1981-1990

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Between 1977 and 1981 the Forest Inventory and Analysis Project at the North Central Forest Experiment Station, in cooperation with the Michigan Department of Natural Resources (DNR) and interested forest industries, inventoried Michigan's forest resources. This survey, part of a nationwide effort mandated by the Forest and Rangeland Renewable Resources Planning Act of 1974, estimated the area of commercial forest land and the volume of timber, growth, mortality, removals, and biomass in the State. In this paper we use data collected from the inventory to estimate the area of commercial forest by kind of forest management opportunity to enhance roundwood production for the decade after the inventory (1981-1990). We also estimate the volume of timber that could be produced as a result of these treatments.

Michigan's commercial forest area of 17.5 million acres in 1980 supported 19.1 billion cubic feet of growing stock, including 47.7 billion board feet[1] of sawtimber. The predominant forest type was maple-birch, which accounted for 6.1 million acres (35 percent) of the commercial forest. The aspen type followed with 3.4 million acres (19 percent) of the area. Poletimber stands totaled 7.8 million acres (44 percent) of the commercial area. Half of the stands in the State are 50 years of age or younger, indicating that preharvest treatments might be appropriate over a large area. Nonindustrial private parties own 53 percent of the commercial forest, suggesting government support in the form of incentive payments, equitable taxation, and education may help accomplish forest treatments. Because only 15 percent of the State's commercial forest is farther than 1 mile from a maintained road[2], accessibility to areas to be treated is not a major problem.

Forest management opportunities and their criteria for the decade 1981 to 1990 were identified with the help of personnel from the Michigan DNR and from published timber management guides. Treatments selected are as follows:

Stand conversion.—clearcutting of stands with low commercial potential and artificially regenerating with tree species of high commercial potential.

Restock.—artificially regenerating (planting or seeding) areas not adequately stocked[3] with growing-stock trees of desirable species or preparing the site to encourage the establishment of natural regeneration.

Harvest.—the final cut in a mature forest stand. In this study the final cut for all forest types except the maple-birch type is assumed to be a clearcut. As explained in greater detail under *Methods*, we assume that some maple-birch stands will be managed under the shelterwood system but that the majority of maple-birch stands will be managed under the tree selection system. For stands under the shelterwood system, the last shelterwood cut is assumed to be the final cut and is included under the harvest treatment. Cuts made by the tree selection system are included under the thinning treatment. We assumed that all harvest cuts will be followed by adequate natural or artificial regeneration. Therefore, harvest acres and volumes are not shown a second time under either the stand conversion or restocking treatments.

Timber stand improvement.—a noncommercial or precommercial partial cut in a forest stand prior to the final harvest cut such as weeding or cleaning. For this study only poletimber stands yielding less than 3 cords per acre are included in this treatment for all forest types except the maple-birch type. Sawtimber stands of the maple-birch type that ordinarily would have been scheduled for thinning except that they would yield less than 3 cords per acre were also scheduled for timber stand improvement.

[1] *International 1/4-inch rule.*

[2] *Any road—hard-topped or other surface—that is plowed or graded at least once a year.*

[3] *Stocking is greater than on nonstocked areas. Stands whose basal area per acre is less than 19 + (0.38 × stand age) and whose stand age is from 10 to 80 years are selected for restocking treatment.*

Release.—removing inhibiting overstory trees of less desirable species from a stand to promote the growth of more desirable understory trees.

Thin.—a commercial partial cut in a forest stand prior to the final harvest cut. Thinning operations must yield at least 3 cords per acre of growing stock. In this report tree selection cuts in the maple-birch type are considered to be thinning treatments.

Some commercial forest land in the State is not included under any of the above treatments but is included in one of the following categories in order to incorporate the entire commercial area:

No treatment.—the stands' condition does not warrant any timber management activity during the current decade.

Nonstocked areas.—commercial forest land currently less than 16.7 percent stocked with growing-stock trees. These areas have little potential for stocking improvement in the near future without management intervention. Some of these areas will be regenerated. However, they differ from stands in the restock treatment because they are more sparsely stocked, and by the need to consider each area separately to judge the efficacy of treatment because site quality is usually unknown.

Hydric sites.—commercial forest land on very wet sites where excess water seriously limits both growth and species occurrence and precludes most commercial timber management activity. Timber can be harvested on these sites when the soil freezes.

No single, true evaluation exists for the management opportunities in Michigan. The rationale for and criteria used in treating stands will differ widely among individuals. The findings presented in this paper result from only one of many possible sets of treatment options.

ASSUMPTIONS

We made three major assumptions in conducting this study: (1) the area of commercial forest land in the State (17.5 million acres in 1980) will decline to 17.4 million by 1985 and to 17.3 million by 1990, (2) all commercial forest land is available for treatment, and (3) markets exist for the sale of all forest products of all commercial species. Because these assumptions may not be realized, estimates generated from this study should be discounted accordingly. We did not consider possible economic, social, or political constraints on management opportunities.

METHODS

We used a modified version of the computer model Stand and Tree Evaluation and Modeling System (STEMS)[4] to project Michigan's forest resource 5 years ahead. In this paper we will call this model FIASTEMS (Forest Inventory and Analysis STEMS). Although forest management opportunities are projected for a decade, actual treatments would be performed each year. Estimates of timber volume removed during the treatment period, should reflect the net growth that would accrue between 1980, the inventory year, and the treatment year. Consequently, we projected each permanent sample plot 5 years to estimate the average growth for the decade before evaluating treatments.

Plot data from the 1980 Michigan forest inventory were used as input to STEMS. STEMS "grew" each plot for 5 years and calculated areas and volumes represented by the plots. Following the projection we used the process illustrated in figure 1 to determine the appropriate treatment. The computer first examined plot data to exclude hydric sites and nonstocked areas. These classes of commercial forest land were set aside and were not included in any of the treatments that follow. In practice, however, hydric sites and nonstocked areas would be considered for treatment on a stand-by-stand basis. Some of this land would be deemed suitable for some kind of forest management.

Stand Conversion

Next, the computer checked the site index of plots in several forest types where timber management is the primary objective to determine whether the stands should be converted to another type. Stands in the maple-birch and oak-hickory types whose site index was less than 55 feet and stands in the aspen-birch type whose site index was less than 60 feet ("off-site" stands) were targeted for conversion to the red pine type (table 1). Such stands are considered unlikely to produce economically viable crops of industrial roundwood if the present forest type prevails. If converted to red pine, these sites could be expected to produce commercial timber crops.

Restock

The remaining plots were examined to single out those that were inadequately stocked with trees. With the help of the FIASTEMS computer program we scanned the records of plots representing nonseedling stands aged 11 to 80 years to find those

[4] *U.S. Department of Agriculture, Forest Service. A description of STEMS: The stand and tree evaluation and modeling system. Gen. Tech. Rep. NC-79. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1982. 18 p.*

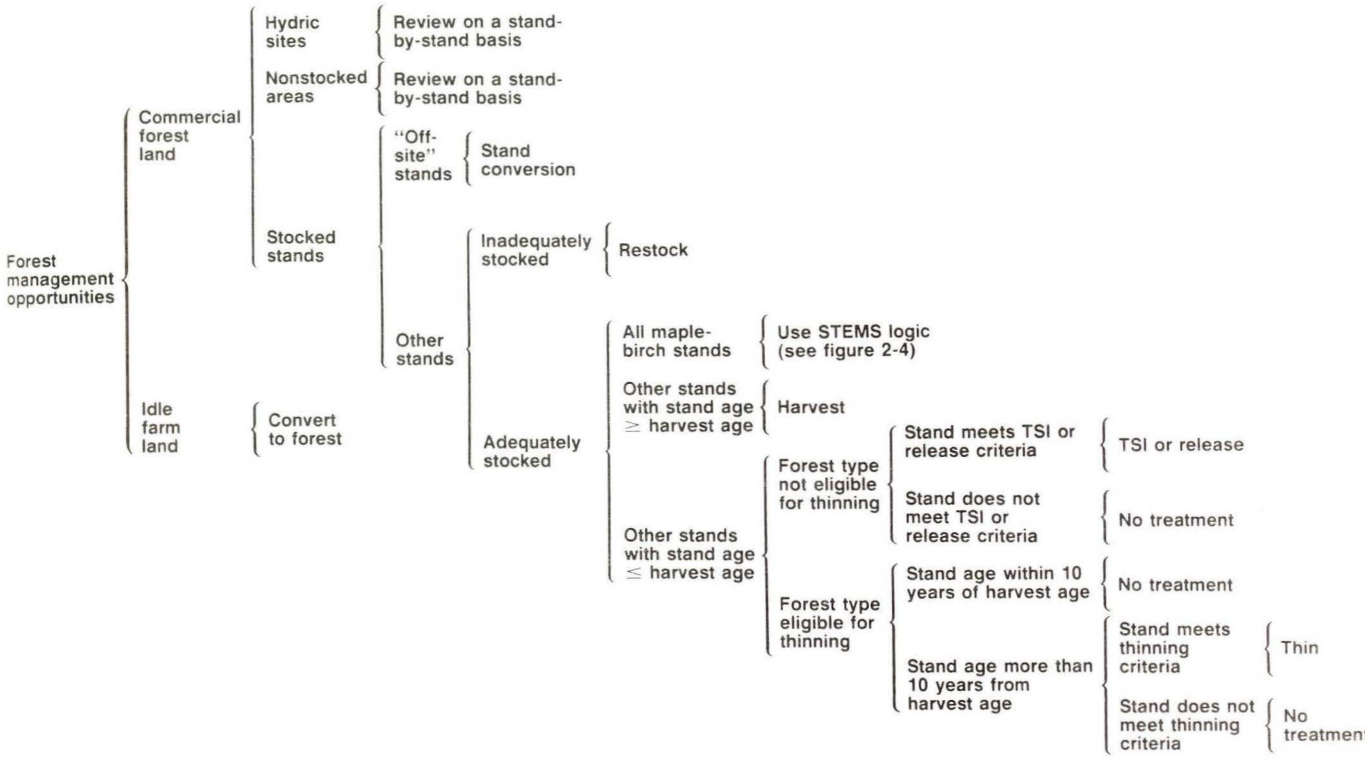

Figure 1.—*Diagram of logic used by the computer to sort Michigan plots into forest management opportunities, 1981-1990.*

whose basal area per acre was less than 19 + (0.38 × stand age).[5] Such stands are not expected to reach an adequate level of stocking by the end of the rotation and were targeted for restocking to forest trees. Stands in all forest types except the paper birch type were scheduled for restocking using this logic. In practice, however, little or no artificial regeneration is performed presently in some types—notably the black spruce, northern white-cedar, tamarack, and aspen types. For these types, the restocking area should be regarded as a measure of the number of inadequately stocked acres on which restocking may one day be a silviculturally viable management option.

Harvest

Next, the FIASTEMS computer program allowed us to separate plots in the maple-birch forest type from the plots that remained and to treat them separately as described below. FIASTEMS scanned the stand age of remaining plots and compared it to the harvest age recommended for each forest type by Michigan DNR foresters (table 1). Plots whose stand age equalled the recommended harvest age at any time during the period 1981-1990 were scheduled for harvesting.

Plots in the maple-birch type were treated differently by the computer program because all-aged rather than even-aged silvicultural systems are used to manage this type. The computer program recognizes three kinds of maple-birch stands: (1) those with a strong yellow birch component, (2) those with a strong hemlock component, and (3) all other maple-birch stands, as explained in more detail below. The logic followed by FIASTEMS for maple-birch plots is shown in figures 2-4 and is modified from Brand (1981)[6]. Brand cited several objectives and assumptions with regard to using this logic:

1. Maintain or develop all-aged maple-birch stands.
2. If possible manage for timber production, particularly for saw and veneer logs.
3. If yellow birch basal area of all live trees is more than 25 percent of the maple-birch basal area, the stand is considered primarily yellow birch (stand composition 1). Maintain these stands using the shelterwood silvicultural system.
4. If hemlock basal area of all live trees is more than 50 percent of the maple-birch basal area, the

[5]*A general equation developed by USDA Forest Service researchers to identify nonseedling stands in which stocking, in relation to age, is so low that the stands are not expected to reach a stocking level adequate for commercial timber production by rotation age.*

[6]*Brand, Gary J. Simulating timber management in Lake States forests. Gen. Tech. Rep. NC-69, St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1981. 25 p.*

Table 1.--Management criteria, Michigan, 1981-1990

Forest type	Stand conversion	Restock	Rotation (harvest) age	Pre-thinning basal area	Post-thinning basal area	Timber stand improvement[1]	Release
			Years	Square feet per acre			
Jack pine	no	yes	50		no	2/	2/
Red pine	no	yes	60	140	90	2/	no
White pine	no	yes	80	140	90	2/	2/
White spruce	no	yes[3]	60		2/	2/	2/
Black spruce	no	yes[3]	70		no	no	no
Balsam fir	no	yes[3]	50		2/	2/	2/
Tamarack	no	yes[3]	60		no	no	no
Northern white-cedar	no	yes[3]	80		no	2/	2/
Oak-hickory	Site index ≤54	yes	70		2/	2/	no
Elm-ash-maple	no	yes	70		no	no	no
Maple-birch	Site index ≤54	yes	2/		2/	2/	2/
Aspen	Site index ≥59	yes[3]	40		no	no	no
Paper birch	Site index ≥59	yes[3]	50		no	no	no
Exotic	no	yes	60		no	no	no

[1] Scheduled only for poletimber stands yielding less than 3 cords of growing stock per acre.

[2] Use management criteria built into the Stand and Tree Evaluation and Modeling System (STEMS). See Brand, Gary J. Simulating timber management in Lake States forests. Gen. Tech. Rep. NC-69. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1981. 25 p.

[3] Presently this forest type is seldom artificially regenerated.

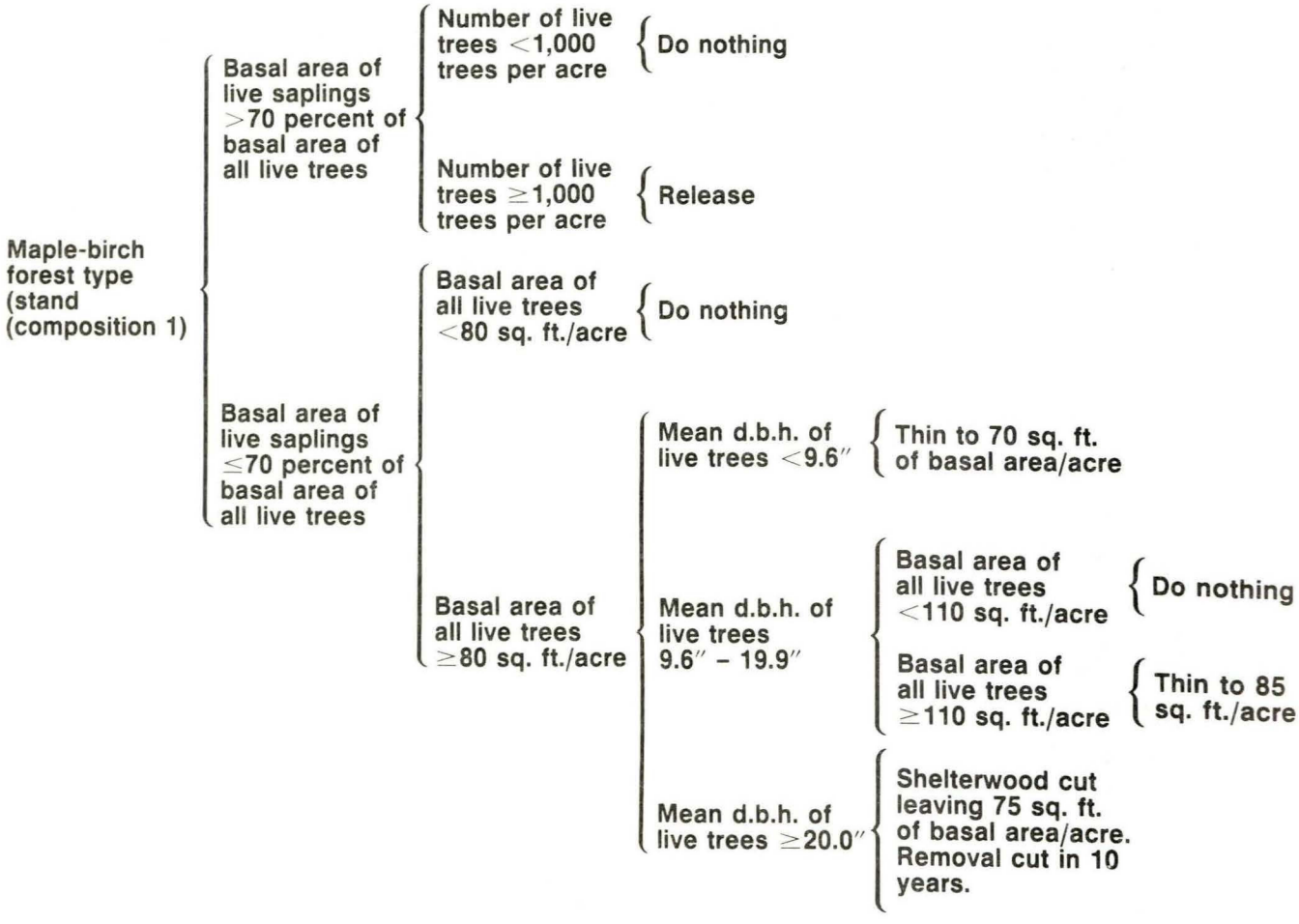
Maple-birch forest type (stand (composition 1)
Basal area of live saplings >70 percent of basal area of all live trees
Number of live trees <1,000 trees per acre
Do nothing
Number of live trees ≥1,000 trees per acre
Release
Basal area of live saplings ≤70 percent of basal area of all live trees
Basal area of all live trees <80 sq. ft./acre
Do nothing
Basal area of all live trees ≥80 sq. ft./acre
Mean d.b.h. of live trees <9.6″
Thin to 70 sq. ft. of basal area/acre
Mean d.b.h. of live trees 9.6″ – 19.9″
Basal area of all live trees <110 sq. ft./acre
Do nothing
Basal area of all live trees ≥110 sq. ft./acre
Thin to 85 sq. ft./acre
Mean d.b.h. of live trees ≥20.0″
Shelterwood cut leaving 75 sq. ft. of basal area/acre. Removal cut in 10 years.

Figure 2.—*Diagram of logic used by the computer to sort plots into treatment classes for those stands in the maple-birch forest type that are primarily yellow birch (stand composition 1).*

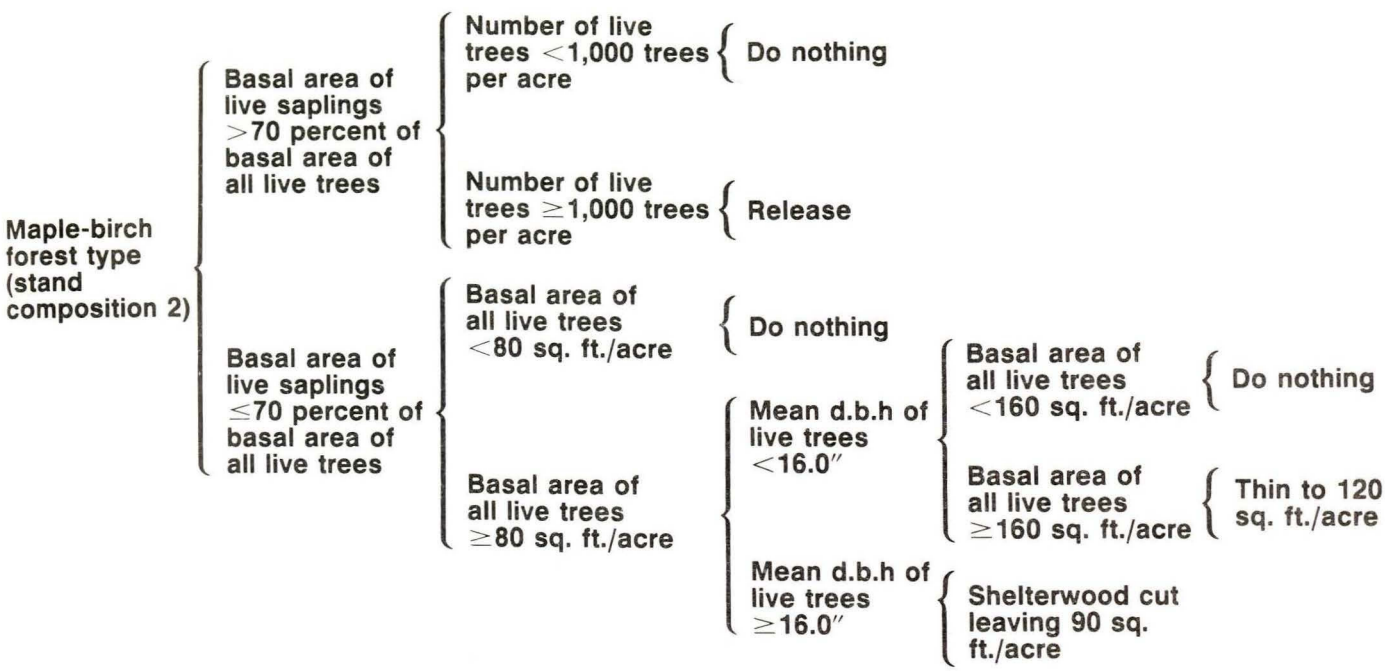
Maple-birch forest type (stand composition 2)
Basal area of live saplings >70 percent of basal area of all live trees
Number of live trees <1,000 trees per acre
Do nothing
Number of live trees ≥1,000 trees per acre
Release
Basal area of live saplings ≤70 percent of basal area of all live trees
Basal area of all live trees <80 sq. ft./acre
Do nothing
Basal area of all live trees ≥80 sq. ft./acre
Mean d.b.h of live trees <16.0″
Basal area of all live trees <160 sq. ft./acre
Do nothing
Basal area of all live trees ≥160 sq. ft./acre
Thin to 120 sq. ft./acre
Mean d.b.h of live trees ≥16.0″
Shelterwood cut leaving 90 sq. ft./acre

Figure 3.—*Diagram of logic used by the computer to sort plots into treatment classes for those stands in the maple-birch forest type that are primarily hemlock (stand composition 2).*

stand is considered primarily hemlock (stand composition 2). Maintain these stands using the shelterwood silvicultural system.

5. If yellow birch basal area is less than 25 percent or hemlock basal area is less than 50 percent—the majority of the maple-birch type—the stand is considered maple-birch (stand composition 3). Maintain these stands using the tree selection system.

Brand also provided marking rules that suggested the species, tree class, and d.b.h. of trees to be removed in partial cuts and in timber stand improvement.

Thinning

The remaining plots, whose stand age would be less than harvest age during the decade, were scanned to determine if the forest type was one considered to be eligible for thinning. Forest managers from the Michigan DNR suggested the following list of types for which thinning was considered silviculturally viable: Red pine, white pine, white spruce, balsam fir, oak-hickory, and maple-birch.

Plots in these types were further scanned to identify those whose stand age would equal harvest age during the decade 1991-2000—stands that would be ready for harvest within 10 years of those presently scheduled for harvest. Such stands were designated as needing no treatment. Plots whose stand age was younger and, therefore, would not be ready for harvest within 10 years of "harvest" plots were then examined to determine whether the stand met the criteria for thinning (as shown in Brand 1981). (Basal area initiating thinning in the red pine and white pine forest types was changed to 140 square feet per acre from that shown by Brand (1981), and post-thinning basal area was changed to 90 square feet per acre as shown in table 1.) These criteria differed for each forest type but generally stands were chosen to be thinned based on stand-age, tree mean d.b.h., and basal area of components of the stand. Examples of the criteria used for the maple-birch forest type are shown in figures 2 to 4. Stands that did not meet thinning criteria were considered to need no treatment.

Timber Stand Improvement and Release

The plots that remained, those not eligible for thinning, were scanned to determine if they were candidates for timber stand improvement (TSI) and release. Forest types suggested by Michigan DNR forest managers as being such candidates are:

TSI	Release
Jack pine	Jack pine
Red pine	White pine
White pine	White spruce
White spruce	Balsam fir
Balsam fir	Northern white-cedar
Northern white-cedar	Maple-birch
Oak-hickory	
Maple-birch	

Plots in these forest types were then analyzed by FIASTEMS to find out if they met the criteria for

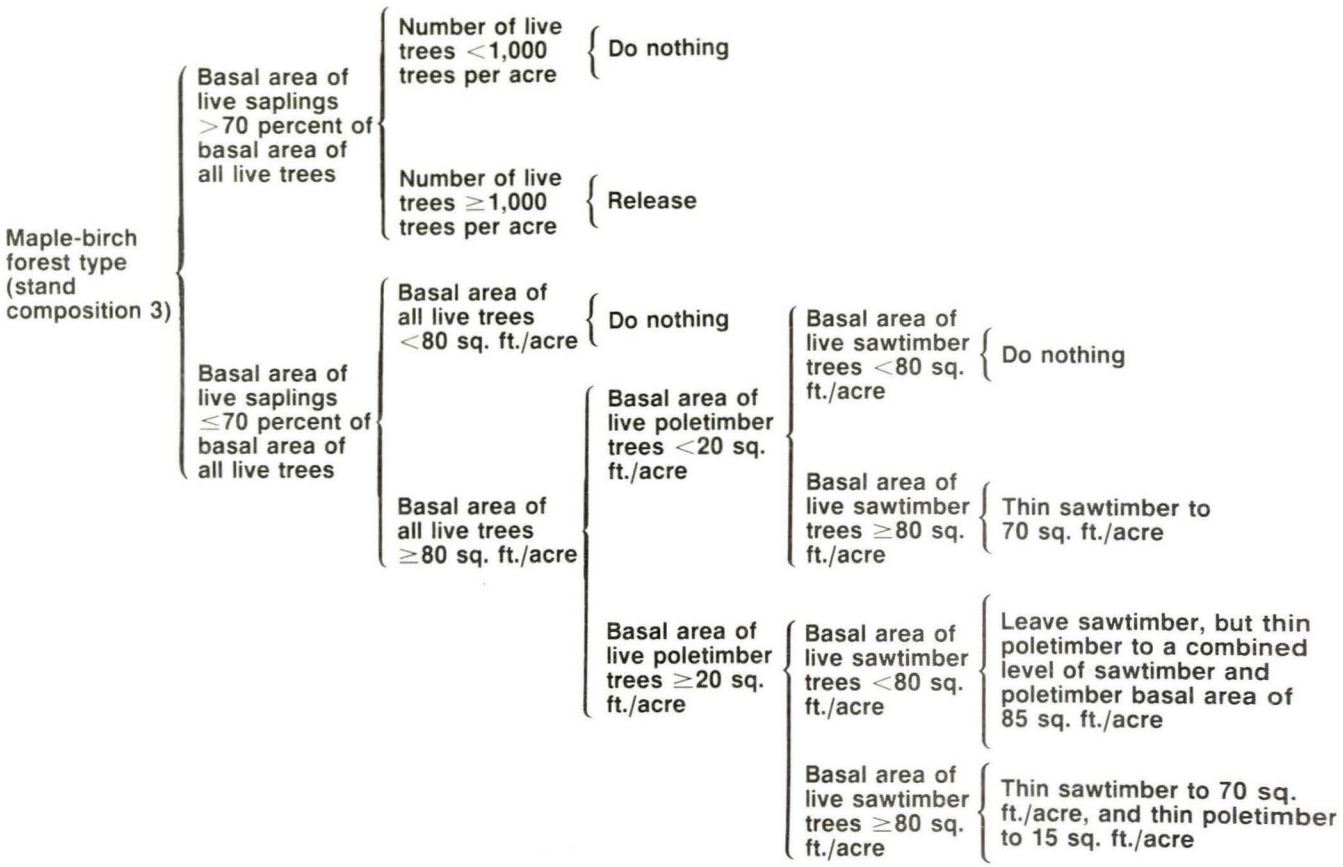
Maple-birch forest type (stand composition 3)
Basal area of live saplings >70 percent of basal area of all live trees
Number of live trees <1,000 trees per acre
Do nothing
Number of live trees ≥1,000 trees per acre
Release
Basal area of live saplings ≤70 percent of basal area of all live trees
Basal area of all live trees <80 sq. ft./acre
Do nothing
Basal area of all live trees ≥80 sq. ft./acre
Basal area of live poletimber trees <20 sq. ft./acre
Basal area of live sawtimber trees <80 sq. ft./acre
Do nothing
Basal area of live sawtimber trees ≥80 sq. ft./acre
Thin sawtimber to 70 sq. ft./acre
Basal area of live poletimber trees ≥20 sq. ft./acre
Basal area of live sawtimber trees <80 sq. ft./acre
Leave sawtimber, but thin poletimber to a combined level of sawtimber and poletimber basal area of 85 sq. ft./acre
Basal area of live sawtimber trees ≥80 sq. ft./acre
Thin sawtimber to 70 sq. ft./acre, and thin poletimber to 15 sq. ft./acre

Figure 4.—*Diagram of logic used by the computer to sort plots into treatment classes for stands in the maple-birch forest type that are neither primarily yellow birch nor hemlock (stand composition 3).*

TSI or release set forth by Brand (1981). Like the thinning criteria discussed earlier, TSI and release criteria differ by forest type. These criteria employ number of trees per acre, stand basal area, and tree mean d.b.h. to select stands for TSI and release work. Poletimber stands that fit the criteria for thinning except that they would yield less than 3 cords of growing stock per acre were targeted for TSI. The remaining plots that did not meet either TSI or release criteria were scheduled for no treatment.

FINDINGS

According to our criteria, 10.9 million acres (63 percent of the commercial forest area) qualify for some kind of forest management beween 1981 and 1990. No treatment is required on 5.8 million acres (33 percent of the commercial forest) and nonstocked areas and hydric sites comprise the remaining 0.8 million acres (4 percent). Most—4.4 million acres (65 percent of the commercial area in the Unit)—of the areas that qualify for forest management treatment are in the Northern Lower Peninsula Survey Unit (fig. 5).

The average annual volume of removals from all treatments is 971 million cubic feet of growing stock. Harvest and thinning alone account for 801 million cubic feet, including 2.6 billion board feet of sawtimber. In addition, these 2 treatments yield an average of 41 million cubic feet of short-log cull and rough and rotten cull tree removals each year.

Harvest Management Opportunities

Area

Harvest represents the most extensive treatment in the State; 4.5 million acres qualify for this type of management between 1981 and 1990 (Appendix table 3). Fifty-four percent (346,000 acres) of the balsam fir forest type area qualifies for harvest, the highest proportion among types. This is due to the large area in stands over rotation age (43 percent of the balsam fir type). The greatest area in the harvest category, however, is the 1.4 million acres in the aspen type, representing 41 percent of the total area of the type. This reflects the overmature condition of much of the State's aspen—47 percent of the aspen type is over rotation age. (The difference between the 47 percent of aspen type over rotation age and the 41 percent of the type in the harvest category is the area of overmature aspen stands selected by FIASTEMS for treatments other than harvest.) Al-

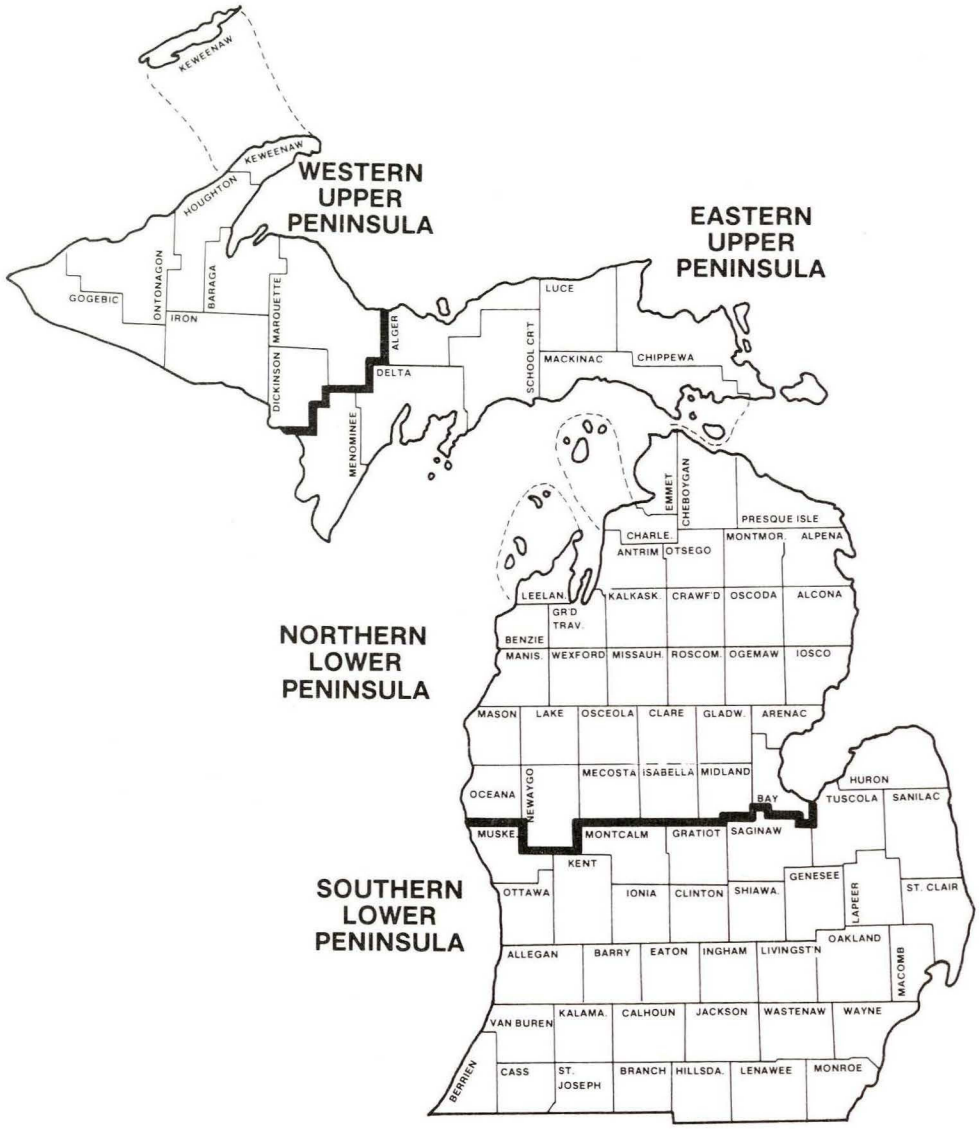

Figure 5.—*Forest Survey Units in Michigan, 1980.*

though the maple-birch type is the largest in the State (6.1 million acres—35 percent of the total commercial forest), only 481,000 acres are identified for harvesting. As mentioned earlier, selective cutting is practiced widely in the maple-birch type, is not considered the final cut in a stand, and is therefore classed under thinning.

Nonindustrial privately owned forest land accounts for 56 percent of the area that qualifies for harvest (roughly equal to the 53 percent of the total commercial forest land held by these owners). Eighty-one percent of the harvest area is in stands more than 50 years old, and 28 percent is in stands more than 90 years old. Much of the area identified for harvest is in small stands—58 percent of the harvest area is in stands less than 20 acres in size. But 12 percent of the harvest area is in stands 160 acres in size and larger.

Volume

The average annual volume of timber removals on the above harvested acres between 1981 and 1990 would be 725 million cubic feet in live trees, of which 690 million is in growing-stock trees. Sawtimber removals would be 2.4 billion board feet annually. Softwoods account for 36 percent of the growing-stock harvest removals volume (245 million cubic feet), although softwoods comprise only 28 percent of the State's growing-stock inventory. The aspens contribute the largest removals volume (152 million cubic feet), followed by soft maple (74 million) and northern white-cedar (72 million). Although aspens represent only 14 percent of the total growing-stock inventory, their removals represent 22 percent of the total volume of removals from harvest. This further reflects the overmature condition of much of the State's aspen.

Forty percent of the growing-stock removals from harvest management opportunities (275 million cubic feet) would come from stands older than 80 years, and 66 percent of it (457 million cubic feet) would come from stands greater than 60 years of age. An average of 1,545 cubic feet of growing stock, including 5,436 board feet of sawtimber, would be removed for each acre identified for harvest. As shown below, annual growing-stock removals per acre would be highest in the red pine type, but sawtimber removals per acre would be greatest in the white pine type:

Forest type	Average harvest volume per acre	
	Growing stock (Cubic feet)	Sawtimber (Board feet)[7]
Red pine	1,962	8,776
White spruce	1,949	6,862
White pine	1,926	8,944
Paper birch	1,759	4,457
Aspen	1,710	5,866
Oak-hickory	1,702	7,715
Northern white-cedar	1,671	4,410
Elm-ash-soft maple	1,634	6,601
Balsam fir	1,579	4,835
Exotic	1,501	5,138
Black spruce	1,305	2,935
Jack pine	1,201	3,507
Tamarack	918	1,712
Maple-birch	723	2,777
Average for all types	1,545	5,436

Thinning Management Opportunities

Area

Thinning is the identified treatment on 1.7 million acres during the decade. About 84 percent (1.4 million acres) of the thinning would be in the maple-birch forest type. As mentioned earlier, selection cuts in the maple-birch type are considered thinnings. The bulk of the thinning area is in the Northern Lower Peninsula Survey Unit (39 percent) and the Western Upper Peninsula Unit (32 percent). Fifty-two percent of the stands that qualify for thinning (880,000 acres) are owned by nonindustrial private parties, virtually the same as the proportion they own of the total commercial forest (53 percent). National Forest land accounts for 19 percent of the thinning acres but for only 14 percent of the commercial area. And State land comprises just 14 percent of the area that qualifies for thinning even though it makes up 20 percent of the commercial forest.

Sixty-three percent of the thinning area is in stands 60 years of age or younger. The remaining 37 percent is entirely within the maple-birch type and represents stands that would be selectively cut.

Volume

Annual removals of 117 million cubic feet of all live trees would result from thinning the above area. Growing-stock removals amount to 111 million cubic feet of it; the remaining 6 million cubic feet would be from short-log, rough, and rotten cull trees. Sixty-three percent of the growing-stock removals are in poletimber-size trees. More than half of the removals volume from thinnings is in hard maple (36 million cubic feet) and soft maple (24 million cubic feet), followed by red pine (11 million), the aspens (6 million), and basswood (5 million). Almost all of the hard and soft maple removals volume is in the maple-birch type.

An average of 663 cubic feet of growing stock would be removed for every acre thinned during the decade. Removals per acre are highest in the white and red pine forest types as shown below:

Forest type	Average volume of thinnings per acre (Cubic feet)
White pine	1,152
Red pine	1,073
White spruce	809
Maple-birch	634
Oak-hickory	594
All types	663

Timber Stand Improvement Management Opportunities

Timber stand improvement (TSI) is the identified treatment on 1.2 million acres. Ninety-four percent of this area is in the maple-birch forest type; the rest is mostly in the oak-hickory type. Forest industry and farmer-owned forest land bears a proportionally greater share of the TSI area than their areas of the total commercial forest. For example, forest industry and farmer-owned forest represent 16 and 26 percent, respectively, of the area selected for TSI. However, they comprise only 11 and 18 percent, respectively, of the commercial forest area. National Forests and State-owned forests display the opposite—proportionally smaller areas of TSI than of the total forest.

TSI was identified for stands of all ages except the 141 year and over age class as shown in the following tabulation (stands in the older age classes are those in the maple-birch forest type that would have been

[7] *International 1/4-inch rule.*

scheduled for thinning had they yielded 3 cords or more per acre):

Stand-age class (Years)	Area of commercial forest land (Thousand acres)
1-10	64.8
11-20	61.4
21-30	74.1
31-40	148.7
41-50	268.4
51-60	212.8
61-70	110.5
71-80	75.8
81-90	68.4
91-100	71.6
101-120	72.5
121-140	12.0
141 +	--
All classes	1,241.0

Fifty-seven percent of stands targeted for TSI are less than 20 acres in size, and 73 percent of them are less than 40 acres in size.

Annual removals of 7 million cubic feet of growing stock would result from TSI work.

Release Management Opportunities

Release is specified on 514,000 acres or 5 percent of the total area for all treatments. Eighty-two percent of the release area is in three forest types—jack pine (208,000 acres), northern white-cedar (116,000), and balsam fir (100,000). The greatest area of release is targeted for State-owned forest (150,000 acres) and National Forest land (131,000). These two owners together account for 54 percent of the release area but for only 34 percent of the total commercial forest. Fifty-six percent of the release area is in stands less than 10 acres in size.

Release would yield annual removals of 6 million cubic feet of growing stock.

Restocking Management Opportunities

Inadequate stocking is seen as a problem on 570,000 acres, or 5 percent of the area to be treated. Every forest type except the paper birch type is scheduled to be restocked. As mentioned earlier, the current practice in the "swamp conifer" and aspen types is to perform no regeneration work. Area in these types classed under the restocking management opportunity, therefore, represent a reservoir of inadequately stocked acres on which growth and yield could be substantially increased if stocking were improved. The maple-birch and aspen types, each with 118,000 acres scheduled for restocking, together lead all other types with 41 percent of the area to be restocked. Nonindustrial private owners are targeted for a larger proportional share of restocking than other owners—although they own 53 percent of the commercial forest, their land represents 63 percent of the area that requires restocking. Two-thirds of the area scheduled for restocking is in stands less than 10 acres in size.

Stand Conversion Management Opportunities

Stand conversion, with a scheduled 2.4 million acres, is the second most extensive treatment. Only four forest types are seen as prospects for stand conversion—maple-birch leads all others (42 percent of the area to be so-treated), followed by aspen (28 percent), oak-hickory (22 percent), and paper birch (8 percent). Ninety-one percent of the area to be converted is on sites capable of growing less than 50 cubic feet per acre per year (the lowest site class) with the existing forest type. If the stands were converted to other types better suited to the site conditions, the timber growth capability in most new stands would be raised. Conversion of forest industry land would be proportionally greater than for other owners. Fifteen percent of the scheduled stand conversion is on forest industry land, but only 11 percent of the commercial forest is forest industry-owned. Forty-two percent of the area to be converted is in stands less than 10 acres in size, and 62 percent of it is in stands less than 20 acres.

Annual growing-stock removals of 157 million cubic feet are estimated from sites identified for stand conversion.

Land Not Scheduled For Management

No Treatment

A total of 5.8 million acres, one-third of the commercial forest area in Michigan, is not scheduled for any treatment. This area includes stands that are adequately stocked and less than harvest age, as well as those that do not meet the criteria for timber stand improvement, thinning or release. Essentially, they are stands that would not benefit biologically from the intervention of man during the next decade.

Hydric Sites

Very wet sites comprise 587,000 acres of commercial forest land. These sites are difficult to manage because they are often inaccessible, except during winter, and because the species growing on these sites grow slowly. Fifty-eight percent of the area of commercial forest land on hydric sites is in the three "swamp conifer" types—northern white-cedar (150,000 acres), black spruce (144,000), and tama-

rack (48,000). Fifty-five percent of the area of hydric sites is in stands less than 10 acres in size.

Nonstocked Areas

Only 172,000 acres of commercial forest land are nonstocked with trees. Some of these areas may not be artificially regenerated to trees because they are too small or have low site productivity. Given the right conditions and time—perhaps much longer than the 10-year period discussed here—many will regenerate naturally. Those that are artificially regenerated will need to be considered independently before planting or seeding to estimate the probable economic and silvicultural success of such action.

DISCUSSION

According to the criteria used in this analysis, 10.9 million acres of the 17.5 million acres of commercial forest land in the State would benefit from some kind of forest management between 1981 and 1990. These criteria, discussed earlier, address only biological considerations. Economic, social, or political constraints to the undertaking of such work are not considered. The estimates shown for each treatment class are biological maximums, given current stand conditions in the State and the treatment criteria used. This is one reason that all 10.9 million acres may not be treated as described earlier. Other reasons are the lack of markets for all the forest products and species removed during treatment, the small area of many stands identified for treatment, some private landowners' present commitment to manage the land for nontimber use, inability of some landowners to afford the cost of some treatments where the sale of timber products is not anticipated to help defray costs, and inaccessibility of some land. The reader should use his or her knowledge of local resource conditions to discount the treatment estimates.

No treatment is suggested for 5.8 million acres of commercial forest. Hydric sites and nonstocked areas comprise the remaining 0.8 million acres of the commercial area.

As shown below, the most widely applied treatment between 1981 and 1990 would be harvest:

Treatment	Area (Thousand acres)	Annual growing-stock removals (Million cubic feet)
Harvest	4,462	690
Stand conversion	2,438	157
Thinning	1,678	111
Timber stand improvement	1,241	7
Restocking	570	([8])
Release	514	6
All treatments	10,903	971

The average annual yield from this harvest is estimated at 690 million cubic feet of growing stock. Thinning, the other treatment most likely to be performed, is seen as a benefit to 1.7 million acres during the decade. Thinning would yield an additional 111 million cubic feet of growing stock annually. These two treatments alone would generate the annual removal of 801 million cubic feet of growing stock.

The large area qualifying for harvest is a measure of the extent of stands over rotation age in some forest types, particularly the aspen and balsam fir types. Some types can remain healthy for decades after passing rotation age, although the growth rates may drop precipitously. However, aspen stands, especially those on low sites, tend to deteriorate or "break up" quickly after reaching this age. Unless harvested very soon thereafter, they will provide little or no commercially valuable fiber. Of the 3.4 million acres in the aspen type in the State, 1.6 million acres are over rotation age (40 years).

An impediment to harvest is that 2.6 million acres of the 4.5 million acres qualifying for this treatment are in stands less than 20 acres in area. Timber operators may consider some of these areas economically unattractive to log unless they are close to other areas to be harvested or support exceptionally large volumes per acre and/or valuable species.

The area and associated volumes of the harvest treatment are slightly understated and the area and associated volumes of the thinning treatment are slightly overstated because tree selection cuts in the maple-birch type are included under thinning.

Stand conversion of the 2.4 million acres identified for this treatment would yield average annual removals of 157 million cubic feet between 1981 and 1990. Twenty-four percent of the conversion area is in stands from 1 to 4 acres in size. Another 18 percent is in stands from 5 to 9 acres in size. These small areas lessen the chances of such stands being treated. Although the size of timber cleared from converted sites may be small and the quality of such trees low, this timber is particularly well suited to whole-tree chipping to produce pulp chips or boiler fuel.

Timber stand improvement on the 1.2 million acres selected would produce 7 million cubic feet of growing-stock removals annually during the decade. Most of the material cut would be too small to be utilized for most roundwood products, but it could be

[8] *An estimated 17 million cubic feet of growing stock occurs on sites identified for restocking, but little of this is likely to be removed.*

used for fuelwood or be whole-tree chipped. Thirty-four percent of the TSI area is in stands less than 10 acres in size, thereby diminishing the likelihood that all these stands will be located and treated.

Annual removals of 6 million cubic feet of growing stock would be generated by release work done on the 0.5 million acres identified for this treatment. Many of the trees to be removed have large diameters, although they may not be of desirable species. Fifty-six percent of the stands qualifying for release are less than 10 acres in size, therefore, many of them probably will not be treated.

Of the 570,000 acres cited for restocking 161,000 acres are in either "swamp conifer" or aspen types where artificial regeneration is not usually practiced. However, the 161,000 acres represents an opportunity to expand the growth and yield in stands where this is not likely to happen without man's intervention. The balance of 409,000 acres in this treatment opportunity is most likely to be restocked.

In addition to the above restocking acres, part of the 172,000 acres of nonstocked commercial forest could also be planted or seeded to trees. Other nonstocked areas may be poor planting chances because of shallow, rocky soil or inadequate soil drainage. Nonstocked areas would have to be inspected on-the-ground to accurately determine which ones represent economically viable opportunities for regeneration.

Stand conversion, timber stand improvement, release, and restocking may be performed less intensively than harvest and thinning for a number of reasons. But these treatments would do much to shift marginally producing commercial forest land closer to its timber-producing potential. At least some of the timber cut from these stands could be sold to help defray the treatment cost. Markets that can utilize chips or small, irregular length, low quality logs, such as for pallet or crate construction, are particularly attractive.

A comparison of the average annual growing-stock removals that would be generated from all forest management opportunities with actual removals for 1979 shows a large difference between the two (table 2).

Average annual removals from all management opportunities (971 million cubic feet) are 3 1/2 times greater than actual removals in 1979 (275 million cubic feet). If only average annual removals from harvest and thinning opportunities are considered, the 801 million cubic feet are still almost three times greater than 1979 removals. The above removals volumes are only for growing-stock trees. If biomass or whole-tree utilization were performed, these volumes could be substantially increased, especially in the aspen type. *The yields from forest management opportunities could not be sustained beyond 1990* and are to be interpreted only as the annual volume that could be removed between 1981 and 1990 if all the treatments were performed. If the treatments are not performed, inventory volumes would still accumulate in the State because growth volumes are projected to exceed removals volumes beyond 1990.

The sustained yield for Michigan from harvest, thinning, and TSI treatments on stocked stands was estimated to fall between 466 and 725 million cubic feet.[9] This estimate was based on an area control technique. Sustainable volumes for the harvest portion alone for growing stock were generated from empirical yield estimates from stands currently at rotation age (373 million cubic feet annually), representing minimal management, and from published yield tables for well-stocked stands (580 million cubic feet), representing more intensive management.

The disparity between average annual removals resulting from all management opportunities between 1981 and 1990 and the 1979 removals would be much greater for softwoods than for hardwoods. Average softwood removals between 1981 and 1990 would be 5.4 times the 1979 softwood removals, compared to 3.0 times for hardwood removals. If only the average annual removals from harvest and thinning are considered, the same numbers are 4.7 times for softwoods and 2.4 times for hardwoods. Among softwood species, northern white-cedar and balsam fir would be harvested at rates elevated the highest above those of 1979.

The treatments discussed in this paper are limited to those on commercial forest land. Opportunities also exist for forest management on wooded strips (241,000 acres), windbreaks (37,000 acres), idle farmland (13,000 acres), and wooded pasture (13,000 acres), all of which are in the nonforest with trees land class.

Landowners desiring assistance in managing their forest land may contact the Michigan (DNR) Cooperative Forest Management Specialist at their local district DNR office. Locations of these district offices are available at the Michigan DNR, Division of Forest Management, Box 30028, Lansing, Michigan 48909, phone: (517) 373-1275. Landowners may also wish to contact forestry consultants and/or forest industry professionals for forest management assistance.

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[9]*Jakes, Pamela J.; Smith, W. Brad. Michigan's predicted timber yields 1981-2010. Res. Pap. NC-243. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1983. 98 p.*

Table 2.--Comparison of average annual growing-stock removals on commercial forest land from forest management opportunities, Michigan, 1981-1990, and actual growing-stock removals estimated for 1979.

(In Million cubic feet)

Item	Total	Softwoods	Hardwoods
Average annual removals, 1981-1990 that would result from:			
Harvest and thinning	800.9	266.5	534.4
All other management opportunities	170.3	40.0	130.3
All opportunities	971.2	306.5	664.7
1979 removals	274.6	56.4	218.2
Difference	696.6	250.1	446.5

APPENDIX

TREE SPECIES GROUPS IN MICHIGAN[10]

Softwoods
- Eastern white pine ..... *Pinus strobus*
- Red pine ..... *Pinus resinosa*
- Jack pine ..... *Pinus banksiana*
- White spruce ..... *Picea glauca*
- Black spruce ..... *Picea mariana*
- Balsam fir ..... *Abies balsamea*
- Eastern hemlock ..... *Tsuga canadensis*
- Tamarack ..... *Larix laricina*
- Northern white-cedar ..... *Thuja occidentalis*
- Other softwoods
  - Eastern redcedar ..... *Juniperus virginiana*
  - Norway spruce ..... *Picea abies*
  - Engelmann spruce ..... *Picea engelmannii*
  - Austrian pine ..... *Pinus nigra*
  - Scotch pine ..... *Pinus sylvestris*

Hardwoods
- White oaks
  - White oak ..... *Quercus alba*
  - Swamp white oak ..... *Quercus bicolor*
  - Bur oak ..... *Quercus macrocarpa*
  - Chinkapin oak ..... *Quercus muehlenbergii*
  - Chestnut oak ..... *Quercus prinus*
- Select red oak
  - Northern red oak ..... *Quercus rubra*
- Other red oaks
  - Scarlet oak ..... *Quercus coccinea*
  - Northern pin oak ..... *Quercus ellipsoidalis*
  - Pin oak ..... *Quercus palustris*
  - Black oak ..... *Quercus velutina*
- Hickories
  - Bitternut hickory ..... *Carya cordiformis*
  - Pignut hickory ..... *Carya glabra*
  - Shellbark hickory ..... *Carya laciniosa*
  - Shagbark hickory ..... *Carya ovata*
  - Mockernut hickory ..... *Carya tomentosa*
- Yellow birch ..... *Betula alleghaniensis*
- Hard maples
  - Sugar maple ..... *Acer saccharum*
  - Black maple ..... *Acer nigrum*
- Soft maples
  - Red maple ..... *Acer rubrum*
  - Silver maple ..... *Acer saccharinum*
- American beech ..... *Fagus grandifolia*
- Ashes
  - White ash ..... *Fraxinus americana*
  - Black ash ..... *Fraxinus nigra*
  - Green ash ..... *Fraxinus pennsylvanica*
- Balsam poplar ..... *Populus balsamifera*
- Eastern cottonwood ..... *Populus deltoides*
- Aspens
  - Bigtooth aspen ..... *Populus grandidentata*
  - Quaking aspen ..... *Populus tremuloides*
- American basswood ..... *Tilia americana*
- Yellow-poplar ..... *Liriodendron tulipifera*
- Black walnut ..... *Juglans nigra*
- Black cherry ..... *Prunus serotina*
- Butternut ..... *Juglans cinerea*
- Elms
  - American elm ..... *Ulmus americana*
  - Slippery elm ..... *Ulmus rubra*
  - Rock elm ..... *Ulmus thomasii*
- Paper birch ..... *Betula papyrifera*
- River birch ..... *Betula nigra*
- Black willow ..... *Salix nigra*
- Sycamore ..... *Platanus occidentalis*
- Other hardwoods
  - Boxelder ..... *Acer negundo*
  - Sweet birch ..... *Betula lenta*
  - Ohio buckeye ..... *Aesculus glabra*
  - Flowering dogwood ..... *Cornus florida*
  - Honeylocust ..... *Gleditsia triacanthos*
  - Osage orange ..... *Maclura pomifera*
  - Black tupelo .. *Nyssa sylvatica var. sylvatica*
  - Black locust ..... *Robinia pseudoacacia*
  - Sassafras ..... *Sassafras albidum*
  - Red mulberry ..... *Morus rubra*
  - American chestnut ..... *Castanea dentata*

[10]*The common and scientific names are based on, Little, Elbert L., Jr. Checklist of United States trees (native and naturalized). Agric. Handbk. 541. Washington, DC: U.S. Department of Agriculture, Forest Service; 1979. 375 p.*

METRIC EQUIVALENTS OF UNITS USED IN THIS REPORT

1 acre = 4,046.86 square meters or 0.405 hectare.
1,000 acres = 405 hectares.
1 cubic foot = 0.0283 cubic meter.
1 foot = 30.48 centimeters or 0.3048 meter.
1 inch = 25.4 millimeters, 2.54 centimeters, or 0.0254 meter.
1 pound = 0.454 kilogram.
1 ton = 0.907 metric ton.

DEFINITION OF TERMS

Basal area.—The area in square feet of the cross section at breast height of a single tree. When the basal area of all trees in a stand are summed, the result is usually expressed as square feet of basal area per acre.

Commercial forest land.—Forest land producing or capable of producing crops of industrial wood and not withdrawn from timber utilization. (Note: Areas qualifying as commercial forest land have the capability of producing in excess of 20 cubic feet per acre per year of annual growth under

management. Currently inaccessible and inoperable areas are included, except when the areas involved are small and unlikely to become suitable for production of industrial wood in the foreseeable future.) Also see definition of pastured commercial forest land.

Commercial species.—Tree species presently or prospectively suitable for industrial wood products. (Note: Excludes species of typically small size, poor form, or inferior quality such as hophornbeam and hawthorn.)

County and municipal land.—Land owned by counties and local public agencies or municipalities, or land leased to these governmental units for 50 years or more.

Cropland.—Land under cultivation within the past 24 months, including cropland harvested, crop failures, cultivated summer fallow, idle cropland used only for pasture, orchards, and land in soil improved crops, but excluding land cultivated in developing improved pasture.

Cull.—Portions of a tree that are unusable for industrial wood products, because of rot, form, or other defect.

Diameter classes.—A classification of trees based on diameter outside bark, measured at breast height (4½ feet above the ground). (Note: d.b.h. is the common abbreviation for diameter at breast height. Two-inch diameter classes are commonly used in Forest Survey, with the even inch the approximate midpoint for a class. For example, the 6-inch class includes trees 5.0 through 6.9 inches d.b.h. inclusive).

Farm.—Any land from which $1,000 or more of agricultural products were grown and sold or normally would have been sold during the year.

Farmer-owned land.—Land owned by farm operators. (Note: Excludes land leased by farm operators from nonfarm owners, such as railroad companies and States.)

Forest land.—Land at least 16.7 percent stocked by forest trees of any size, or formerly having had such tree cover, and not currently developed for nonforest use. (Note: Stocking is measured by comparison of basal area and/or number of trees, by age or size and spacing with specified standards.) The minimum area for classification of forest land is 1 acre. Roadside, streamside, and shelterbelt strips of timber must have a crown width of at least 120 feet to qualify as forest land. Unimproved roads and trails, streams, or other bodies of water or clearings in forest areas shall be classed as forest if less than 120 feet wide. Also see definitions for land area, commercial forest land, noncommercial forest land, productive-reserved forest land, stocking, unproductive forest land, and water.

Forest industry land.—Land owned by companies or individuals operating primary wood-using plants.

Forest trees.—Woody plants having a well-developed stem and usually more than 12 feet in height at maturity.

Forest type.—A classification of forest land based upon the species forming a plurality of live tree stocking. Major forest types in Michigan are:

Jack pine.—Forests in which jack pine comprises a plurality of the stocking. (Common associates include eastern white pine, red pine, aspen, birch, and maple.)

Red pine.—Forests in which red pine comprises a plurality of the stocking. (Common associates include eastern white pine, jack pine, aspen, birch, and maple.)

White pine.—Forests in which eastern white pine comprises a plurality of the stocking. (Common associates include red pine, jack pine, aspen, birch, and maple.)

Balsam fir.—Forests in which balsam fir and white spruce comprise a plurality of the stocking with balsam fir the most common. (Common associates include white spruce, aspen, maple, birch, northern white-cedar, and tamarack.)

White spruce.—Forests in which white spruce and balsam fir comprise a plurality of the stocking with white spruce the most common. (Common associates include balsam fir, aspen, maple, birch, northern white-cedar, and tamarack.)

Black spruce.—Forests in which swamp conifers comprise a plurality of the stocking with black spruce the most common. (Common associates include tamarack and northern white-cedar.)

Northern white-cedar.—Forests in which swamp conifers comprise a plurality of the stocking with northern white-cedar the most common. (Common associates include tamarack and black spruce.)

Tamarack.—Forests in which swamp conifers comprise a plurality of the stocking with tamarack the most common. (Common associates include black spruce and northern white-cedar.)

Oak-hickory.—Forests in which northern red oak, white oak, bur oak, or hickories, singly or in combination, comprise a plurality of the stocking. (Common associates include jack pine, beech, yellow-poplar, elm, and maple.)

Elm-ash-soft maple.—Forests in which lowland elm, ash, cottonwood, and red maple, singly or in combination, comprise a plurality of the stocking. (Common associates include birches, spruce, and balsam fir.)

Maple-birch.—Forests in which sugar maple, basswood, yellow birch, upland American elm, and red maple, singly or in combination, comprise a plurality of the stocking. (Common associates include white pine, elm, hemlock, and basswood.)

Aspen.—Forests in which quaking aspen or bigtooth aspen, singly or in combination, comprise a

plurality of the stocking. (Common associates include balsam poplar, balsam fir, and paper birch.)

Paper birch.—Forests in which paper birch comprises a plurality of the stocking. (Common associates include maple, aspen, and balsam fir.)

Exotic.—Forests in which species not native to Michigan comprise a plurality of the stocking. (Mostly scotch pine plantations.)

Growing-stock trees.—Live trees of commercial species qualifying as desirable and acceptable trees. (Note: Excludes rough, rotten, and dead trees.)

Growing-stock volume.—Net volume in cubic feet of growing-stock trees 5 inches d.b.h. and over from a 1-foot stump to a minimum 4 inch top diameter outside bark of the central stem or to the point where the central stem breaks into limbs. Cubic feet can be converted to standard cords by dividing by 79. One standard cord is 128 cubic feet of stacked wood, including bark and air.

Hardwoods.—Dicotyledonous trees, usually broad-leaved and deciduous.

Indian land.—All lands held in trust by the United States for individual Indians or tribes, or all lands, titles to which are held by individual Indians or tribes, subject to Federal restrictions against alienation.

Industrial wood.—All roundwood products, except fuelwood.

Land area.—A. *Bureau of the Census*.—The area of dry land and land temporarily or partly covered by water, such as marshes, swamps, and river flood plains (omitting tidal flats below mean high tide); streams, sloughs, estuaries, and canals less than one-eighth of a statute mile wide; and lakes, reservoirs, and ponds less than 40 acres in area.

B. *Forest Inventory and Analysis*. The same as the Bureau of the Census, except minimum width of streams, etc. is 120 feet and minimum size of lakes, etc. is 1 acre.

Live trees.—Growing-stock, rough and rotten trees 1 inch d.b.h. and larger.

Log grades.—A classification of logs based on external characteristics as indicators of quality or value. (See Appendix for specific grading factors used.)

Logging residues.—The unused growing-stock portions of trees cut or killed by logging.

Merchantable.—Refers to a pulpwood or saw log section that meets pulpwood or saw log specifications, respectively.

Miscellaneous federal land.—Federal land other than National Forest and land administered by the Bureau of Land Management.

Miscellaneous private land.—Privately owned land other than forest-industry and farmer-owned land.

Mortality.—The volume of sound wood in growing-stock and sawtimber trees that die annually.

National Forest land.—Federal land that has been legally designated as National Forest or purchase units, and other land under the administration of the USDA Forest Service.

Net annual growth of growing stock.—The annual change in volume of sound wood in live sawtimber and poletimber trees and the total volume of trees entering these classes through ingrowth, less volume losses resulting from natural causes.

Net annual growth of sawtimber.—The annual change in the volume of live sawtimber trees and the total volume of trees reaching sawtimber size, less volume losses resulting from natural causes.

Net volume.—Gross volume less deductions for rot, sweep, or other defect affecting use for timber products.

Noncommercial forest land.—(a) Unproductive forest land and (b) productive-reserved forest land.

Noncommercial species.—Tree species of typically small size, poor form, or inferior quality which normally do not develop into trees suitable for industrial wood products.

Nonforest land.—Land that has never supported forests, and land formerly forested where use for timber management is precluded by development for other uses. (Note: Includes areas used for crops, improved pasture, residential areas, city parks, improved roads of any width and adjoining clearings, powerline clearings of any width, and 1- to 40-acre areas of water classified by the Bureau of the Census as land. If intermingled in forest areas, unimproved roads and nonforest strips must be more than 120 feet wide and more than 1 acre in area, to qualify as nonforest land.)

a. *Nonforest land without trees*.—Nonforest land with no live trees present.

b. *Nonforest land with trees*.—Nonforest land with one or more trees per acre at least 5 inches d.b.h.

Nonstocked land.—Commercial forest land less than 16.7 percent stocked with growing-stock trees.

Other removals.—Growing-stock trees removed but not utilized for products, or trees left standing but "removed" from the commercial forest land classification by land use change. Examples are removals from cultural operations such as timber stand improvement work, land clearing, and changes in land use.

Ownership.—Property owned by one owner, regardless of the number of parcels in a specified area.

Ownership size class.—The amount of commercial forest land owned by one owner, regardless of the number or parcels.

Poletimber stands.—(See stand-size class.)

Poletimber trees.—Growing-stock trees of commercial species at least 5 inches d.b.h., but smaller than sawtimber size.

Productive-reserved forest land.—Forest land sufficiently productive to qualify as commercial forest land but withdrawn from timber utilization through statute, administrative regulation, designation, or exclusive use for Christmas tree production, as indicated by annual shearing.

Rotten trees.—Live trees of commercial species that do not contain at least one 12-foot saw log or two saw logs 8 feet or longer, now or prospectively, and/or do not meet Regional specifications for freedom from defect primarily because of rot; that is, when more than 50 percent of the cull volume in a tree is rotten.

Rough trees.—(a) Live trees of commercial species that do not contain at least one merchantable 12-foot saw log or two saw logs 8 feet or longer, now or prospectively, and/or do not meet Regional specifications for freedom from defect primarily because of roughness or poor form, and (b) all live trees of noncommercial species.

Roundwood products.—Logs, bolts, or other round sections (including chips from roundwood) cut from trees for industrial or consumer uses. (Note: Includes saw logs, veneer logs and bolts; cooperage logs and bolts; pulpwood; fuelwood; piling; poles; posts; hewn ties; mine timbers; and various other round, split, or hewn products.)

Salvable dead trees.—Standing or down dead trees that are considered merchantable by Regional standards.

Saplings.—Live trees 1- to 5-inches d.b.h.

Sapling-seedling stands.—(See stand-size class.)

Saw log.—A log meeting minimum standards of diameter, length, and defect, including logs at least 8 feet long, sound and straight and with a minimum diameter outside bark (d.o.b.) for softwoods of 7 inches (9 inches for hardwoods) or other combinations of size and defect specified by Regional standards.

Saw log portion.—That part of the bole of sawtimber trees between the stump and the saw log top.

Saw log top.—The point on the bole of sawtimber trees above which a saw log cannot be produced. The minimum saw log top is 7 inches d.o.b. for softwoods and 9 inches d.o.b. for hardwoods.

Sawtimber stands.—(See stand-size class.)

Sawtimber trees.—Growing-stock trees of commercial species containing at least a 12-foot saw log or two noncontiguous saw logs 8 feet or longer, and meeting Regional specifications for freedom from defect. Softwoods must be at least 9 inches d.b.h. Hardwoods must be at least 11 inches d.b.h.

Sawtimber volume.—Net volume of the saw log portion of live sawtimber in board feet, International 1/4-inch rule, from stump to a minimum 7 inches top diameter outside bark (d.o.b.) for softwoods and a minimum 9 inches top d.o.b. for hardwoods.

Seedlings.—Live trees less than 1 inch d.b.h. that are expected to survive. Only softwood seedlings more than 6 inches tall and hardwood seedlings more than 1 foot tall are counted.

Short-log (rough tree).—Sawtimber-size trees of commercial species that contain at least one merchantable 8- to 11-foot saw log but not a 12-foot saw log.

Site class.—A classification of forest land in terms of inherent capacity to grow crops of industrial wood based on fully stocked natural stands.

Site index.—An expression of forest site quality based on the height of a free-growing dominant or codominant tree of a representative species in the forest type at age 50.

Softwoods.—Coniferous trees, usually evergreen, having needles or scale-like leaves.

Stand.—A growth of trees on a minimum of 1 acre of forest land that is stocked by forest trees of any size.

Stand-age class.—Age of the main stand. Main stand refers to trees of the dominant forest type and stand-size class.

Stand-area class.—The extent of a continuous forested area of the same forest type, stand-size class, and stand-density class.

Stand-size class.—A classification of forest land based on the size class of growing-stock trees on the area; that is, sawtimber, poletimber or seedlings and saplings.

a. *Sawtimber stands*.—Stands at least 16.7 percent stocked with growing-stock trees, with half or more of total stocking in sawtimber or poletimber trees, and with sawtimber stocking at least equal to poletimber stocking.

b. *Poletimber stands*.—Stands at least 16.7 percent stocked with growing-stock trees of which half or more of this stocking is in poletimber and/or sawtimber trees, and with poletimber stocking exceeding that of sawtimber.

c. *Sapling-seedling stands*.—Stands at least 16.7 percent stocked with growing-stock trees of which more than half of the stocking is saplings and/or seedlings.

d. *Nonstocked areas*.—Commercial forest land on which stocking of growing-stock trees is less than 16.7 percent.

State land.—Land owned by States, or land leased to these governmental units for 50 years or more.

Stocking.—The degree of occupancy of land by trees, measured by basal area and/or the number of trees in a stand by size or age and spacing, compared to the basal area and/or number of trees required to fully utilize the growth potential of the land; that is, the stocking standard.

A stocking percent of 100 indicates full utilization of the site and is equivalent to 80 square feet

of basal area per acre in trees 5 inches d.b.h. and larger. In a stand of trees less than 5 inches d.b.h., a stocking percent of 100 would indicate that the present number of trees is sufficient to produce 80 square feet of basal area per acre when the trees reach 5 inches d.b.h.

Stands are grouped into the following stocking classes:

Overstocked stands.—Stands in which stocking of trees is 134.0 percent or more.

Fully stocked stands.—Stands in which stocking of trees is from 101.0 to 133.9 percent.

Medium stocked stands.—Stands in which stocking of trees is from 61.0 to 100.9 percent.

Poorly stocked stands.—Stands in which stocking of trees is from 16.7 to 60.9 percent.

Nonstocked areas.—Commercial forest land on which stocking of trees is less than 16.7 percent.

Timber removals from growing stock.—The volume of sound wood in growing-stock trees removed annually for forest products (including roundwood products and logging residues) and for other removals.

Timber removals from sawtimber.—The net board-foot volume of live sawtimber trees removed for forest products annually (including roundwood products and logging residues) and for other removals.

Tree size class.—A classification of trees based on diameter at breast height, including sawtimber trees, poletimber trees, saplings, and seedlings.

Unproductive forest land.—Forest land incapable of producing 20 cubic feet per acre of annual growth or of yielding crops of industrial wood under natural conditions because of adverse site conditions. (Note: Adverse conditions include shallow soils, dry climate, poor drainage, high elevation, steepness, and rockiness.

Upper stem portion.—That part of the bole of sawtimber trees above the saw log top to a minimum top diameter of 4 inches outside bark or to the point where the central stem breaks into limbs.

Water.—(a) *Bureau of the Census*.—Streams, sloughs, estuaries, and canals more than one-eighth of a statute mile wide; and lakes, reservoirs, and ponds more than 40 acres in area.

(b) *Noncensus*.—The same as the Bureau of the Census, except minimum width of streams, etc. is 120 feet and minimum size of lakes, etc. is 1 acre.

Wooded pasture.—Improved pasture with more than 16.7 percent stocking in live trees but less than 25 percent stocking in growing-stock trees. Area is currently improved for grazing or there is other evidence of grazing.

Wooded strip.—An acre or more of natural continuous forest land that would otherwise meet survey standards for commercial forest land except that it is less than 120 feet wide.

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Table 3.--Area of commercial forest land qualifying for management by forest type, treatment, and Forest Survey Unit, Michigan, 1981-1990

(In thousand acres)

Forest type	All commercial forest land	Treatment						Untreated		
		Harvest	Thinning	Timber stand improvement	Release	Restocking	Stand conversion	Nonstocked	Hydric sites	No treatment
ALL UNITS										
Jack pine	836.7	337.1	--	--	207.8	75.4	--	--	4.1	212.3
Red pine	655.9	90.3	121.7	1.7	--	36.2	--	--	1.7	404.3
White pine	214.1	86.9	2.5	--	44.2	16.9	--	--	5.4	58.2
Balsam fir	635.4	345.7	--	--	100.1	17.9	--	--	39.6	132.1
White spruce	100.1	34.4	4.4	--	30.0	7.8	--	--	1.4	22.1
Black spruce	520.6	59.5	--	--	--	16.7[1/]	--	--	144.2	300.2
Northern white-cedar	1,173.6	490.4	--	--	116.0	19.0[1/]	--	--	150.2	398.0
Tamarack	114.8	22.3	--	--	--	7.4[1/]	--	--	47.6	37.5
Oak-hickory	1,773.6	547.1	141.5	68.3	--	38.7	534.3	--	--	443.7
Elm-ash-soft maple	1,326.4	426.1	--	--	--	95.2	--	--	127.4	677.7
Maple-birch	6,098.4	481.0	1,407.5	1,171.0	16.4	117.7	1,029.9	--	15.4	1,859.5
Aspen	3,406.6	1,403.7	--	--	--	117.8[1/]	683.8	--	43.6	1,157.7
Paper birch	374.8	128.5	--	--	--	--	189.6	--	5.9	50.8
Exotic	86.3	9.3	--	--	--	3.5	--	--	--	73.5
Nonstocked	172.2	--	--	--	--	--	--	172.2	--	--
All types	17,489.5	4,462.3	1,677.6	1,241.0	514.5	570.2	2,437.6	172.2	586.5	5,827.6
EASTERN UPPER PENINSULA										
Jack pine	229.1	98.3	--	--	41.7	30.1	--	--	0.7	58.3
Red pine	139.8	21.8	14.3	--	--	9.0	--	--	1.7	93.0
White pine	68.7	26.6	--	--	9.3	6.3	--	--	1.5	25.0
Balsam fir	217.4	101.6	--	--	37.4	2.7	--	--	7.9	67.8
White spruce	30.1	10.4	4.4	--	2.7	4.8	--	--	--	7.8
Black spruce	283.1	19.5	--	--	--	8.6[1/]	--	--	62.3	192.7
Northern white-cedar	594.9	218.5	--	--	49.7	8.3[1/]	--	--	79.0	239.4
Tamarack	43.8	14.5	--	--	--	4.4[1/]	--	--	11.2	13.7
Oak-hickory	19.3	3.1	1.9	1.5	--	1.6	2.0	--	--	9.2
Elm-ash-soft maple	191.8	70.9	--	--	--	7.3	--	--	8.9	104.7
Maple-birch	1,160.3	60.1	293.8	203.1	--	8.6	259.0	--	1.4	334.3
Aspen	671.4	243.4	--	--	--	20.4[1/]	210.5	--	27.7	169.4
Paper birch	110.5	31.4	--	--	--	--	61.5	--	4.6	13.0
Exotic	1.2	--	--	--	--	--	--	--	--	1.2
Nonstocked	40.2	--	--	--	--	--	--	40.2	--	--
All types	3,801.6	920.1	314.4	204.6	140.8	112.1	533.0	40.2	206.9	1,329.5
WESTERN UPPER PENINSULA										
Jack pine	88.3	58.5	--	--	6.3	2.9	--	--	1.6	19.0
Red pine	57.6	21.9	3.0	--	--	--	--	--	--	32.7
White pine	48.7	26.0	--	--	3.2	1.7	--	--	--	17.8
Balsam fir	366.6	209.7	--	--	53.2	13.5	--	--	30.5	59.7
White spruce	40.6	16.8	--	--	12.4	--	--	--	1.4	10.0
Black spruce	209.5	35.0	--	--	--	4.3[1/]	--	--	73.7	96.5
Northern white-cedar	210.2	112.1	--	--	8.3	--	--	--	25.9	63.9
Tamarack	36.0	1.3	--	--	--	1.2[1/]	--	--	20.7	12.8
Oak-hickory	22.6	6.4	3.2	--	--	--	8.0	--	--	5.0
Elm-ash-soft maple	169.7	84.6	--	--	--	3.4	--	--	7.8	73.9
Maple-birch	2,372.4	227.5	534.8	372.4	3.2	1.3	482.4	--	2.3	748.5
Aspen	733.3	373.2	--	--	--	20.8[1/]	130.8	--	3.3	205.2
Paper birch	143.8	60.8	--	--	--	--	65.3	--	1.3	16.4
Exotic	1.6	--	--	--	--	--	--	--	--	1.6
Nonstocked	28.7	--	--	--	--	--	--	28.7	--	--
All types	4,529.6	1,233.8	541.0	372.4	86.6	49.1	686.5	28.7	168.5	1,363.0

[1/] Artificial regeneration is not usually practiced in this type.

(Table 3 continued on next page)

(Table 3 continued)

Forest type	All commercial forest land	Treatment						Untreated		
		Harvest	Thinning	Timber stand improvement	Release	Restocking	Stand conversion	Nonstocked	Hydric sites	No treatment
NORTHERN LOWER PENINSULA										
Jack pine	506.7	172.8	--	--	159.8	42.4	--	--	1.8	129.9
Red pine	427.0	46.6	97.8	1.7	--	27.2	--	--	--	253.7
White pine	75.2	34.3	2.5	--	23.4	4.0	--	--	3.9	7.1
Balsam fir	51.4	34.4	--	--	9.5	1.7	--	--	1.2	4.6
White spruce	21.9	7.2	--	--	7.4	3.0	--	--	--	4.3
Black spruce	28.0	5.0	--	--	--	3.8[1/]	--	--	8.2	11.0
Northern white-cedar	355.5	159.6	--	--	58.0	4.5[1/]	--	--	45.3	88.1
Tamarack	30.6	6.5	--	--	--	1.8[1/]	--	--	15.7	6.6
Oak-hickory	1,068.1	208.8	88.0	38.5	--	16.9	444.0	--	--	271.9
Elm-ash-soft maple	416.3	126.7	--	--	--	37.3	--	--	41.9	210.4
Maple-birch	1,662.4	122.4	470.1	395.1	2.6	46.1	231.5	--	7.6	387.0
Aspen	1,817.5	731.1	--	--	--	66.3[1/]	317.3	--	12.6	690.2
Paper birch	113.9	36.3	--	--	--	--	59.5	--	--	18.1
Exotic	57.2	4.5	--	--	--	3.5	--	--	--	49.2
Nonstocked	63.2	--	--	--	--	--	--	63.2	--	--
All types	6,694.9	1,696.2	658.4	435.3	260.7	258.5	1,052.3	63.2	138.2	2,132.1
SOUTHERN LOWER PENINSULA										
Jack pine	12.6	7.5	--	--	--	--	--	--	--	5.1
Red pine	31.5	--	6.6	--	--	--	--	--	--	24.9
White pine	21.5	--	--	--	8.3	4.9	--	--	--	8.3
Balsam fir	--	--	--	--	--	--	--	--	--	--
White spruce	7.5	--	--	--	7.5	--	--	--	--	--
Black spruce	--	--	--	--	--	--	--	--	--	--
Northern white-cedar	13.0	0.2	--	--	--	6.2[1/]	--	--	--	6.6
Tamarack	4.4	--	--	--	--	--	--	--	--	4.4
Oak-hickory	663.6	328.8	48.4	28.3	--	20.2	80.3	--	--	157.6
Elm-ash-soft maple	548.6	143.9	--	--	--	47.2	--	--	68.8	288.7
Maple-birch	903.3	71.0	108.8	200.4	10.6	61.7	57.0	--	4.1	389.7
Aspen	184.4	56.0	--	--	--	10.3[1/]	25.2	--	--	92.9
Paper birch	6.6	--	--	--	--	--	3.3	--	--	3.3
Exotic	26.3	4.8	--	--	--	--	--	--	--	21.5
Nonstocked	40.1	--	--	--	--	--	--	40.1	--	--
All types	2,463.4	612.2	163.8	228.7	26.4	150.5	165.8	40.1	72.9	1,003.0

[1/] Artificial regeneration is not usually practiced in this type.

Table 4.--Area of commercial forest land by forest type, site class, and treatment, Michigan, 1981-1990

(In thousand acres)

Forest type	All classes	Site class					
		225+	165-224	120-164	85-119	50-84	20-49
HARVEST							
Jack pine	337.1	--	--	--	14.2	92.1	230.8
Red pine	90.3	--	--	--	23.8	53.0	13.5
White pine	86.9	--	--	6.3	18.4	42.9	19.3
Balsam fir	345.7	1.6	1.7	47.9	172.9	94.7	26.9
White spruce	34.4	--	--	--	3.1	17.2	14.1
Black spruce	59.5	--	--	--	--	4.4	55.1
Northern white-cedar	490.4	--	--	--	--	38.5	451.9
Tamarack	22.3	--	--	--	--	11.0	11.3
Oak-hickory	547.1	--	--	13.1	160.4	346.6	27.0
Elm-ash-soft maple	426.1	--	--	--	83.4	89.7	253.0
Maple-birch	481.0	--	--	21.5	111.3	267.4	80.8
Aspen	1,403.7	--	--	52.2	624.9	726.6	--
Paper birch	128.5	--	--	1.9	2.2	102.9	21.5
Exotic	9.3	--	--	--	2.2	7.1	--
All types	4,462.3	1.6	1.7	142.9	1,216.8	1,894.1	1,205.2
THINNING							
Red pine	121.7	--	--	18.2	59.3	44.2	--
White pine	2.5	--	--	--	2.5	--	--
White spruce	4.4	--	--	--	1.5	2.9	--
Oak-hickory	141.5	--	--	--	26.5	115.0	--
Maple-birch	1,407.5	--	--	35.4	260.5	869.6	242.0
All types	1,677.6	--	--	53.6	350.3	1,031.7	242.0
TIMBER STAND IMPROVEMENT							
Red pine	1.7	--	--	--	1.7	--	--
Oak-hickory	68.3	--	--	--	13.9	47.6	6.8
Maple-birch	1,171.0	--	--	34.5	239.8	657.1	239.6
All types	1,241.0	--	--	34.5	255.4	704.7	246.4
RELEASE							
Jack pine	207.8	--	--	--	2.6	27.1	178.1
White pine	44.2	--	--	4.3	14.8	17.4	7.7
Balsam fir	100.1	--	1.6	10.1	48.7	17.3	22.4
White spruce	30.0	--	--	--	14.7	15.3	--
Northern white-cedar	116.0	--	--	--	--	5.1	110.9
Maple-birch	16.4	--	--	--	6.5	8.3	1.6
All types	514.5	--	1.6	14.4	87.3	90.5	320.7

(Table 4 continued on next page)

(Table 4 continued)

Forest type	All classes	Site class 225+	165-224	120-164	85-119	50-84	20-49
RESTOCKING							
Jack pine	75.4	--	--	--	--	10.3	65.1
Red pine	36.2	--	--	--	5.4	27.8	3.0
White pine	16.9	--	--	1.7	--	9.8	5.4
Balsam fir	17.9	--	--	--	14.8	--	3.1
White spruce	7.8	--	--	--	4.6	3.2	--
Black spruce[1/]	16.7	--	--	--	--	--	16.7
Northern white-cedar[1/]	19.0	--	--	--	--	10.7	8.3
Tamarack[1/]	7.4	--	--	--	--	1.8	5.6
Oak-hickory	38.7	--	--	4.9	--	27.8	6.0
Elm-ash-soft maple	95.2	--	--	--	18.2	16.3	60.7
Maple-birch	117.7	--	--	--	7.8	68.6	41.3
Aspen[1/]	117.8	--	--	--	57.3	60.5	--
Exotic	3.5	--	--	--	--	3.5	--
All types	570.2	--	--	6.6	108.1	240.3	215.2
STAND CONVERSION							
Oak-hickory	534.3	--	--	--	--	--	534.3
Maple-birch	1,029.9	--	--	--	--	--	1029.9
Aspen	683.8	--	--	--	--	191.1	492.7
Paper birch	189.6	--	--	--	--	21.5	168.1
All types	2,437.6	--	--	--	--	212.6	2,225.0
NONSTOCKED							
Nonstocked	172.2	--	--	2.4	13.8	48.3	107.7
HYDRIC SITES							
Jack pine	4.1	--	--	--	--	1.6	2.5
Red pine	1.7	--	--	--	--	1.7	--
White pine	5.4	--	--	--	--	--	5.4
Balsam fir	39.6	--	--	--	12.0	16.2	11.4
White spruce	1.4	--	--	--	--	1.4	--
Black spruce	144.2	--	--	--	--	5.5	138.7
Northern white-cedar	150.2	--	--	--	--	7.5	142.7
Tamarack	47.6	--	--	--	--	7.3	40.3
Elm-ash-soft maple	127.4	--	--	--	14.7	31.9	80.8
Maple-birch	15.4	--	--	--	--	2.7	12.7
Aspen	43.6	--	--	--	30.6	2.3	10.7
Paper birch	5.9	--	--	--	--	--	5.9
All types	586.5	--	--	--	57.3	78.1	451.1

[1/] Artificial regeneration is not usually practiced in this type.

Table 5.--Area of commercial forest land by ownership class, site class, and treatment, Michigan, 1981-1990

(In thousand acres)

Forest type	All classes	Site class 225+	165-224	120-164	85-119	50-84	20-49
HARVEST							
National forest	482.2	--	--	7.4	76.7	265.1	133.0
Miscellaneous federal	12.7	--	--	1.5	8.3	--	2.9
State	965.7	1.6	1.7	28.8	230.7	353.2	349.7
County and municipal	39.7	--	--	--	16.7	13.1	9.9
Indian	9.8	--	--	--	1.7	6.6	1.5
Forest industry	447.8	--	--	14.5	74.5	158.8	200.0
Farmer	812.3	--	--	30.6	290.1	346.0	145.6
Miscellaneous private	1,692.1	--	--	60.1	518.1	751.3	362.6
All owners	4,462.3	1.6	1.7	142.9	1,216.8	1,894.1	1,205.2
THINNING							
National forest	320.8	--	--	3.0	59.2	193.8	64.8
Miscellaneous federal	1.6	--	--	--	--	1.6	--
State	236.7	--	--	7.0	33.6	178.2	17.9
County and municipal	27.0	--	--	2.6	6.6	12.9	4.9
Indian	4.9	--	--	--	--	4.9	--
Forest industry	206.6	--	--	1.5	23.8	129.2	52.1
Farmer	341.2	--	--	27.0	113.3	175.6	25.3
Miscellaneous private	538.8	--	--	12.5	113.8	335.5	77.0
All owners	1,677.6	--	--	53.6	350.3	1,031.7	242.0
TIMBER STAND IMPROVEMENT							
National forest	86.2	--	--	--	13.2	41.8	31.2
State	190.7	--	--	--	32.7	123.4	34.6
County and municipal	14.0	--	--	--	1.6	10.8	1.6
Forest industry	194.3	--	--	--	28.3	112.9	53.1
Farmer	318.1	--	--	21.4	87.8	163.6	45.3
Miscellaneous private	437.7	--	--	13.1	91.8	252.2	80.6
All owners	1,241.0	--	--	34.5	255.4	704.7	246.4
RELEASE							
National forest	130.6	--	--	--	8.4	6.3	115.9
State	149.8	--	--	4.8	16.6	27.5	100.9
County and municipal	4.8	--	--	--	2.5	--	2.3
Forest industry	66.2	--	--	1.6	27.2	15.0	22.4
Farmer	56.1	--	--	3.9	10.5	11.8	29.9
Miscellaneous private	107.0	--	1.6	4.1	22.1	29.9	49.3
All owners	514.5	--	1.6	14.4	87.3	90.5	320.7

(Table 5 continued on next page)

(Table 5 continued)

Forest type	All classes	Site class 225+	165-224	120-164	85-119	50-84	20-49
RESTOCKING							
National forest	51.1	--	--	--	14.1	13.5	23.5
Miscellaneous federal	5.4	--	--	--	--	5.4	--
State	127.7	--	--	--	19.6	50.7	57.4
County and municipal	4.6	--	--	--	--	4.6	--
Indian	1.6	--	--	--	--	1.6	--
Forest industry	23.4	--	--	--	4.2	10.3	8.9
Farmer	137.8	--	--	6.6	15.2	56.7	59.3
Miscellaneous private	218.6	--	--	--	55.0	97.5	66.1
All owners	570.2	--	--	6.6	108.1	240.3	215.2
STAND CONVERSION							
National forest	395.4	--	--	--	--	39.3	356.1
Miscellaneous federal	11.0	--	--	--	--	--	11.0
State	534.4	--	--	--	--	61.8	472.6
County and municipal	17.5	--	--	--	--	--	17.5
Indian	1.5	--	--	--	--	--	1.5
Forest industry	369.9	--	--	--	--	13.6	356.3
Farmer	273.0	--	--	--	--	23.6	249.4
Miscellaneous private	834.9	--	--	--	--	74.3	760.6
All owners	2,437.6	--	--	--	--	212.6	2,225.0
NONSTOCKED							
National forest	24.6	--	--	--	--	19.4	5.2
Miscellaneous federal	2.8	--	--	--	--	--	2.8
State	50.4	--	--	--	3.2	6.8	40.4
Forest industry	4.3	--	--	--	--	--	4.3
Farmer	26.6	--	--	--	5.4	--	21.2
Miscellaneous private	63.5	--	--	2.4	5.2	22.1	33.8
All owners	172.2	--	--	2.4	13.8	48.3	107.7
HYDRIC SITES							
National forest	88.8	--	--	--	34.9	--	53.9
State	145.1	--	--	--	--	21.0	124.1
County and municipal	2.9	--	--	--	--	--	2.9
Forest industry	92.8	--	--	--	1.6	12.4	78.8
Farmer	84.3	--	--	--	12.8	22.0	49.5
Miscellaneous private	172.6	--	--	--	8.0	22.7	141.9
All owners	586.5	--	--	--	57.3	78.1	451.1

Table 6.--Area of commercial forest land by treatment and stand-area class, Michigan, 1981-1990

(In thousand acres)

Treatment	All classes	Stand-area class (acres) 1-4	5-9	10-19	20-39	40-79	80-159	160-319	320-639	640+
Harvest	4,462.3	828.2	775.6	989.5	865.2	248.4	198.7	492.4	29.9	34.4
Thinning	1,677.6	217.6	234.4	303.9	458.4	121.6	73.4	214.2	17.2	36.9
Timber stand improvement	1,241.0	187.8	228.8	292.0	191.2	85.9	70.7	164.0	5.0	15.6
Release	514.5	183.7	103.8	79.0	59.6	5.9	31.6	45.5	--	5.4
Restocking	570.2	246.5	118.5	68.7	69.3	23.8	17.3	21.6	4.5	--
Stand conversion	2,437.6	583.5	438.0	479.3	481.7	111.5	77.6	229.7	4.6	31.7
Nonstocked	172.2	51.1	51.6	17.4	7.5	8.9	14.8	18.5	--	2.4
Hydric sites	586.5	211.6	113.8	96.3	49.9	17.0	19.3	76.3	--	2.3

Table 7.--Area of commercial forest land qualifying for harvest by forest type and stand-age class, Michigan, 1981-1990

(In thousand acres)

Forest type	All classes	Stand-age class (years)												
		1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-120	121-140	141+
Jack pine	337.1	--	--	--	--	133.2	107.0	38.3	34.8	14.6	4.4	2.3	2.5	--
Red pine	90.3	--	--	--	--	--	9.2	23.5	16.1	14.1	7.7	18.2	1.5	--
White pine	86.9	--	--	--	--	--	--	--	15.3	22.9	20.4	13.0	10.6	4.7
Balsam fir	345.7	--	--	--	--	81.4	91.5	57.1	42.2	22.5	12.9	23.6	9.7	4.8
White spruce	34.4	--	--	--	--	--	6.6	3.3	4.8	7.9	--	9.6	--	2.2
Black spruce	59.5	--	--	--	--	--	--	18.8	10.7	3.2	3.2	10.5	7.3	5.8
Northern white-cedar	490.4	--	--	--	--	--	--	--	63.5	117.3	74.5	117.0	62.4	55.7
Tamarack	22.3	--	--	--	--	--	8.8	5.8	3.3	1.5	2.9	--	--	--
Oak-hickory	547.1	--	--	--	--	--	--	65.4	146.2	117.9	71.9	118.5	23.8	3.4
Elm-ash-soft maple	426.1	--	--	--	--	--	--	54.8	89.1	85.2	45.0	91.8	45.9	14.3
Maple-birch	481.0	--	--	--	--	--	29.0	48.7	64.6	86.4	73.9	129.5	40.4	8.5
Aspen	1,403.7	--	--	--	172.7	433.6	338.5	178.4	127.1	69.8	51.2	32.4	--	--
Paper birch	128.5	--	--	--	--	18.9	74.0	24.7	5.5	--	3.9	1.5	--	--
Exotic	9.3	--	--	--	--	2.2	7.1	--	--	--	--	--	--	--
All types	4,462.3	--	--	--	172.7	669.3	671.7	518.8	623.2	563.3	371.9	567.9	204.1	99.4

Table 8.--Area of commercial forest land qualifying for thinning by forest type and stand-age class, Michigan, 1981-1990

(In thousand acres)

Forest type	All classes	Stand-age class (years)												
		1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-120	121-140	141+
Jack pine	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Red pine	121.7	--	--	66.0	43.4	12.3	--	--	--	--	--	--	--	--
White pine	2.5	--	--	--	--	--	2.5	--	--	--	--	--	--	--
Balsam fir	--	--	--	--	--	--	--	--	--	--	--	--	--	--
White spruce	4.4	--	--	--	--	4.4	--	--	--	--	--	--	--	--
Black spruce	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Northern white-cedar	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Tamarack	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Oak-hickory	141.5	--	--	4.1	43.7	61.1	32.6	--	--	--	--	--	--	--
Elm-ash-soft maple	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Maple-birch	1,407.5	--	--	20.8	97.9	362.9	313.4	156.1	83.6	110.8	89.3	120.3	43.3	9.1
Aspen	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Paper birch	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Exotic	--	--	--	--	--	--	--	--	--	--	--	--	--	--
All types	1,677.6	--	--	90.9	185.0	440.7	348.5	156.1	83.6	110.8	89.3	120.3	43.3	9.1

Table 9.--Average annual growing-stock and sawtimber removals on commercial forest land qualifying for harvest by species group and tree class, Michigan, 1981-1990

Species group	Total all live	Growing-stock			Short-log cull	Rough and rotten cull	Sawtimber
		Total	Poletimber	Sawtimber			
	Thousand cubic feet						Thousand board feet 1/
Softwoods							
Jack pine	33,653	33,010	15,314	17,696	167	476	88,749
Red pine	20,690	20,596	2,950	17,646	37	57	98,561
White pine	28,409	28,011	1,524	26,487	146	252	146,646
White spruce	26,089	25,618	5,340	20,278	71	400	102,876
Black spruce	11,409	11,345	8,122	3,223	4	60	15,637
Balsam fir	43,488	42,936	27,616	15,320	79	473	70,972
Hemlock	8,692	8,216	1,166	7,050	197	279	41,201
Tamarack	2,869	2,817	1,600	1,217	11	41	5,559
Eastern redcedar	22	22	--	22	--	--	103
Northern white-cedar	78,123	71,886	34,908	36,978	1,309	4,928	179,082
Other softwoods	1,087	1,032	241	791	--	55	3,659
Total	254,531	245,489	98,781	146,708	2,021	7,021	753,045
Hardwoods							
White oak	29,365	28,292	3,519	24,773	376	697	134,704
Select red oak	45,976	44,433	5,557	38,876	621	922	210,758
Other red oak	11,970	11,171	1,034	10,137	157	642	54,526
Hickory	5,574	5,466	1,058	4,408	87	21	23,207
Basswood	6,998	6,496	1,973	4,523	69	433	23,673
Beech	1,686	1,482	665	817	37	167	4,559
Yellow birch	6,376	5,378	1,458	3,920	309	689	21,320
Hard maple	20,757	18,254	7,992	10,262	685	1,818	53,563
Soft maple	79,650	74,193	26,696	47,497	1,164	4,293	234,627
Elm	6,293	6,078	2,247	3,831	46	169	22,111
Black ash	11,409	11,000	5,621	5,379	52	357	29,868
White and green ash	10,606	10,422	2,756	7,666	81	103	41,691
Sycamore	318	318	--	318	--	--	1,557
Cottonwood	2,983	2,979	15	2,964	--	4	14,952
Willow	1,236	1,086	47	1,039	--	150	5,430
Hackberry	94	94	27	67	--	--	380
Balsam poplar	13,917	13,692	1,746	11,946	38	187	64,876
Bigtooth aspen	60,694	58,380	15,545	42,835	359	1,955	228,269
Quaking aspen	100,591	94,073	26,216	67,857	882	5,636	363,433
Paper birch	43,058	40,705	21,904	18,801	219	2,134	101,933
River birch	32	32	19	13	--	--	76
Black cherry	8,088	7,357	2,139	5,218	204	527	28,100
Black walnut	1,113	1,094	63	1,031	--	19	4,913
Butternut	118	96	--	96	--	22	488
Yellow poplar	248	248	--	248	--	--	1,269
Other hardwoods	1,430	1,260	799	461	9	161	2,523
Total	470,580	444,079	129,096	314,983	5,395	21,106	1,672,806
All species	725,111	689,568	227,877	461,691	7,416	28,127	2,425,851

1/International 1/4-inch rule.

Table 10.--Average annual growing-stock and sawtimber removals on commercial forest land qualifying for thinning by species group and tree class, Michigan, 1981-1990

Species group	Total all live	Growing-stock			Short-log cull	Rough and rotten cull	Sawtimber
		Total	Poletimber	Sawtimber			
	Thousand cubic feet						Thousand board feet[1]
Softwoods							
Jack pine	1,427	1,308	1,062	246	29	90	1,248
Red pine	11,363	11,208	10,004	1,204	--	155	6,856
White pine	906	863	234	629	14	29	3,199
White spruce	539	539	336	203	--	--	1,017
Black spruce	208	208	160	48	--	--	214
Balsam fir	3,304	3,268	2,709	559	--	36	2,549
Hemlock	1,737	1,636	764	872	24	77	4,901
Tamarack	9	9	9	--	--	--	--
Eastern redcedar	--	--	--	--	--	--	--
Northern white-cedar	1,907	1,700	1,123	577	8	199	2,697
Other softwoods	235	235	235	--	--	--	--
Total	21,635	20,974	16,636	4,338	75	586	22,681
Hardwoods							
White oak	1,751	1,635	839	796	33	83	4,222
Select red oak	2,522	2,369	1,836	533	57	96	2,556
Other red oak	827	721	451	270	106	--	1,458
Hickory	558	526	313	213	--	32	1,018
Basswood	4,929	4,766	3,204	1,562	--	163	6,720
Beech	841	764	489	275	34	43	1,429
Yellow birch	645	609	476	133	9	27	683
Hard maple	37,734	35,833	18,984	16,849	173	1,728	85,571
Soft maple	24,883	23,743	14,999	8,744	114	1,026	35,301
Elm	2,737	2,572	1,776	796	22	143	5,070
Black ash	931	905	810	95	--	26	503
White-green ash	3,026	2,911	1,718	1,193	69	46	6,217
Sycamore	68	68	20	48	--	--	259
Cottonwood	144	144	27	117	--	--	624
Willow	--	--	--	--	--	--	--
Hackberry	--	--	--	--	--	--	--
Balsam poplar	60	52	22	30	--	8	172
Bigtooth aspen	3,721	3,601	2,070	1,531	--	120	8,063
Quaking aspen	2,922	2,719	1,468	1,251	7	196	6,487
Paper birch	2,573	2,468	1,519	949	--	105	5,135
River birch	--	--	--	--	--	--	--
Black cherry	3,475	3,247	1,903	1,344	--	228	8,258
Black walnut	333	298	87	211	35	--	1,111
Butternut	--	--	--	--	--	--	--
Yellow poplar	--	--	--	--	--	--	--
Other hardwoods	380	380	118	262	--	--	1,463
Total	95,060	90,331	53,129	37,202	659	4,070	182,320
All species	116,695	111,305	69,765	41,540	734	4,656	205,001

[1] International 1/4-inch rule.

Table 11.--Average annual growing-stock removals on commercial forest land qualifying for harvest by species group and forest type, Michigan, 1981-1990

(In thousand cubic feet)

Species group	All types	Forest type													
		Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack	Oak-hickory	Elm-ash-maple	Maple-birch	Aspen	Paper birch	Exotic
Softwoods															
Jack pine	33,010	30,294	626	239	37	11	151	--	65	522	--	--	877	102	86
Red pine	20,596	3,491	10,648	1,442	422	87	100	75	--	664	--	22	3,283	250	112
White pine	28,011	967	2,658	9,757	2,629	417	455	2,655	--	1,362	1,358	749	4,402	391	211
White spruce	25,618	44	223	514	11,477	2,994	248	2,698	--	50	1,063	316	5,680	311	--
Black spruce	11,345	497	144	442	2,308	135	3,325	3,293	164	24	324	26	626	37	--
Balsam fir	42,936	149	248	319	17,445	795	667	5,773	107	20	2,285	552	13,472	1,104	--
Hemlock	8,216	--	129	160	700	9	92	1,036	--	83	1,522	3,450	789	246	--
Tamarack	2,817	--	--	43	176	--	209	722	1,225	--	136	19	208	79	--
Eastern redcedar	22	--	--	--	--	--	--	--	--	22	--	--	--	--	--
Northern white-cedar	71,886	--	54	139	4,480	1,001	1,550	51,774	271	--	5,080	599	5,807	1,119	12
Other softwoods	1,032	--	93	--	10	--	--	--	--	153	--	--	--	--	776
Total	245,489	35,442	14,823	13,055	39,684	5,449	6,797	68,026	1,832	2,900	11,768	5,733	35,144	3,639	1,197
Hardwoods															
White oak	28,292	200	112	362	--	--	--	--	--	24,235	1,487	428	1,413	55	--
Select red oak	44,433	2,212	689	404	59	--	--	--	--	29,544	798	1,239	8,986	502	--
Other red oak	11,171	765	98	--	--	--	--	--	--	9,704	130	--	437	0	37
Hickory	5,466	27	--	--	--	--	--	--	--	5,031	245	145	--	18	--
Basswood	6,496	15	--	--	14	--	--	52	--	771	1,866	1,649	1,851	278	--
Beech	1,482	--	--	33	--	--	--	--	--	310	187	437	508	7	--
Yellow birch	5,378	--	--	47	898	18	114	829	--	42	1,945	717	568	200	--
Hard maple	18,254	--	18	351	521	76	--	444	--	708	1,323	8,917	5,070	826	--
Soft maple	74,193	412	427	666	3,814	249	214	3,415	--	5,852	27,622	8,229	21,147	2,146	--
Elm	6,078	--	--	11	352	12	--	54	--	478	2,159	1,627	1,369	--	16
Black ash	11,000	--	--	--	286	--	116	1,375	11	274	7,594	137	1,104	103	--
White and green ash	10,422	--	--	--	23	--	--	88	--	1,504	4,711	2,462	1,501	133	--
Sycamore	318	--	--	--	--	--	--	--	--	46	184	88	--	--	--
Cottonwood	2,979	--	--	--	--	--	--	--	--	400	1,351	172	1,056	--	--
Willow	1,086	--	--	--	--	--	--	--	--	--	875	147	64	--	--
Hackberry	94	--	--	--	--	--	--	--	--	--	94	--	--	--	--
Balsam poplar	13,692	--	9	--	885	187	--	912	43	--	771	87	10,478	320	--
Bigtooth aspen	58,380	141	518	127	172	--	--	195	--	4,480	334	427	51,330	605	51
Quaking aspen	94,073	1,116	519	1,034	4,048	533	328	1,411	87	723	1,808	632	80,169	1,592	73
Paper birch	40,705	93	419	628	3,423	182	197	5,056	74	855	1,194	439	15,964	12,181	--
River birch	32	--	--	--	--	--	--	32	--	--	--	--	--	--	--
Black cherry	7,357	43	89	20	393	--	--	57	--	3,189	764	1,009	1,771	--	22
Black walnut	1,094	--	--	--	--	--	--	--	--	1,033	61	--	--	--	--
Butternut	96	--	--	--	--	--	--	--	--	15	81	--	--	--	--
Yellow poplar	248	--	--	--	--	--	--	--	--	102	101	45	--	--	--
Other hardwoods	1,260	27	--	--	--	--	--	--	--	943	189	--	101	--	--
Total	444,079	5,051	2,898	3,683	14,888	1,257	969	13,920	215	90,239	57,874	29,033	204,887	18,966	199
All species	689,568	40,493	17,721	16,738	54,572	6,706	7,766	81,946	2,047	93,139	69,642	34,766	240,031	22,605	1,396

Table 12.--Average annual growing-stock removals on commercial forest land qualifying for thinning by species group and forest type, Michigan, 1981-1990

(In thousand cubic feet)

Species group	All types	Forest type													
		Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack	Oak-hickory	Elm-ash-maple	Maple-birch	Aspen	Paper birch	Exotic
Softwoods															
Jack pine	1,308	--	1,069	18	--	--	--	--	--	221	--	--	--	--	--
Red pine	11,208	--	10,192	50	--	28	--	--	--	477	--	461	--	--	--
White pine	863	--	149	79	--	107	--	--	--	59	--	469	--	--	--
White spruce	539	--	--	--	--	--	--	--	--	--	--	539	--	--	--
Black spruce	208	--	--	--	--	--	--	--	--	16	--	192	--	--	--
Balsam fir	3,268	--	58	--	--	17	--	--	--	--	--	3,193	--	--	--
Hemlock	1,636	--	--	--	--	8	--	--	--	--	--	1,628	--	--	--
Tamarack	9	--	--	--	--	--	--	--	--	--	--	9	--	--	--
Eastern redcedar	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Northern white-cedar	1,700	--	--	--	--	9	--	--	--	--	--	1,691	--	--	--
Other softwoods	235	--	40	--	--	--	--	--	--	--	--	195	--	--	--
Total	20,974	--	11,508	147	--	169	--	--	--	773	--	8,377	--	--	--
Hardwoods															
White oak	1,635	--	490	20	--	--	--	--	--	604	--	521	--	--	--
Select red oak	2,369	--	98	--	--	--	--	--	--	1,523	--	748	--	--	--
Other red oak	721	--	316	--	--	--	--	--	--	405	--	--	--	--	--
Hickory	526	--	--	--	--	--	--	--	--	243	--	283	--	--	--
Basswood	4,766	--	45	--	--	--	--	--	--	--	--	4,721	--	--	--
Beech	764	--	53	--	--	11	--	--	--	--	--	700	--	--	--
Yellow birch	609	--	--	--	--	--	--	--	--	--	--	609	--	--	--
Hard maple	35,833	--	18	--	--	--	--	--	--	--	--	35,815	--	--	--
Soft maple	23,743	--	322	15	--	12	--	--	--	1,587	--	21,807	--	--	--
Elm	2,572	--	--	--	--	--	--	--	--	81	--	2,491	--	--	--
Black ash	905	--	--	--	--	--	--	--	--	28	--	877	--	--	--
White and green ash	2,911	--	7	--	--	--	--	--	--	92	--	2,812	--	--	--
Sycamore	68	--	--	--	--	--	--	--	--	--	--	68	--	--	--
Cottonwood	144	--	--	--	--	--	--	--	--	82	--	62	--	--	--
Willow	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hackberry	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Balsam poplar	52	--	--	--	--	11	--	--	--	--	--	41	--	--	--
Bigtooth aspen	3,601	--	89	92	--	--	--	--	--	1,834	--	1,586	--	--	--
Quaking aspen	2,719	--	--	--	--	71	--	--	--	339	--	2,309	--	--	--
Paper birch	2,468	--	--	--	--	82	--	--	--	239	--	2,147	--	--	--
River birch	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Black cherry	3,247	--	117	14	--	--	--	--	--	252	--	2,864	--	--	--
Black walnut	298	--	--	--	--	--	--	--	--	298	--	--	--	--	--
Butternut	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Yellow poplar	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other hardwoods	380	--	--	--	--	--	--	--	--	23	--	357	--	--	--
Total	90,331	--	1,555	141	--	187	--	--	--	7,630	--	80,818	--	--	--
All species	111,305	--	13,063	288	--	356	--	--	--	8,403	--	89,195	--	--	--

Table 13.--Average annual sawtimber removals on commercial forest land qualifying for harvest by species group and forest type, Michigan, 1981-1990

(In thousand board feet)[1/]

Species group	All types	Forest type: Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack	Oak-hickory	Elm-ash-maple	Maple-birch	Aspen	Paper birch	Exotic
Softwoods															
Jack pine	88,749	80,223	1,907	899	99	58	374	--	269	1,707	--	--	2,305	472	436
Red pine	98,561	15,783	53,643	7,925	2,183	490	551	331	--	2,504	--	136	13,843	916	256
White pine	146,646	4,218	13,003	51,894	14,084	2,217	2,382	15,416	--	7,000	7,592	3,820	22,376	1,835	809
White spruce	102,876	230	624	1,942	47,310	12,197	1,225	10,950	--	187	4,666	1,306	21,025	1,214	--
Black spruce	15,637	325	--	661	4,299	324	2,771	5,068	344	74	876	93	802	--	--
Balsam fir	70,972	646	401	472	31,888	1,799	593	7,186	141	--	3,402	629	22,038	1,777	--
Hemlock	41,201	--	417	970	3,841	59	544	6,143	--	454	7,612	17,498	2,674	989	--
Tamarack	5,559	--	--	163	477	--	393	1,417	1,908	--	567	88	546	--	--
Eastern redcedar	103	--	--	--	--	--	--	--	--	103	--	--	--	--	--
Northern white-cedar	179,082	--	71	282	13,597	2,687	5,319	125,618	511	--	14,355	2,112	12,798	1,732	--
Other softwoods	3,659	--	186	--	--	--	--	--	--	698	--	--	--	--	2,775
Total	753,045	101,425	70,252	65,208	117,778	19,831	14,152	172,129	3,173	12,727	39,070	25,682	98,407	8,935	4,276
Hardwoods															
White oak	134,704	817	637	1,977	--	--	--	--	--	115,377	7,980	2,143	5,525	248	--
Select red oak	210,758	8,068	3,414	1,359	131	--	--	--	--	147,078	3,930	6,512	38,081	2,185	--
Other red oak	54,526	2,919	567	--	--	--	--	--	--	48,363	742	--	1,762	--	173
Hickory	23,207	141	--	--	--	--	--	--	--	21,824	803	343	--	96	--
Basswood	23,673	--	--	--	--	--	--	287	--	2,653	7,747	5,508	6,113	1,365	--
Beech	4,559	--	--	128	--	--	--	--	--	1,051	917	1,682	739	42	--
Yellow birch	21,320	--	--	200	4,215	53	554	3,845	--	69	8,535	2,207	1,320	322	--
Hard maple	53,563	--	110	1,131	1,794	224	--	1,396	--	2,967	5,023	27,948	10,535	2,435	--
Soft maple	234,627	958	479	1,507	9,216	181	434	8,704	--	16,593	120,654	28,638	43,387	3,876	--
Elm	22,111	--	--	--	1,100	70	--	230	--	315	7,426	8,090	4,880	--	--
Black ash	29,868	--	--	--	577	--	292	2,122	--	474	24,504	285	1,460	154	--
White and green ash	41,691	--	--	--	--	--	--	202	--	7,127	18,008	11,623	4,293	438	--
Sycamore	1,557	--	--	--	--	--	--	--	--	232	904	421	--	--	--
Cottonwood	14,952	--	--	--	--	--	--	--	--	1,998	6,776	920	5,258	--	--
Willow	5,430	--	--	--	--	--	--	--	--	--	4,373	728	329	--	--
Hackberry	380	--	--	--	--	--	--	--	--	--	380	--	--	--	--
Balsam poplar	64,876	--	55	--	4,487	976	--	5,294	189	--	4,123	393	47,849	1,510	--
Bigtooth aspen	228,269	439	1,369	689	890	--	--	1,009	--	17,413	1,646	1,969	200,257	2,588	--
Quaking aspen	363,433	3,259	1,086	3,017	16,024	1,800	1,376	6,499	285	1,903	8,983	2,703	310,020	6,280	198
Paper birch	101,933	72	962	2,402	9,669	471	655	14,222	171	2,790	5,063	1,378	37,275	26,803	--
River birch	76	--	--	--	--	--	--	76	--	--	--	--	--	--	--
Black cherry	28,100	108	317	106	1,251	--	--	262	--	13,863	2,102	4,156	5,804	--	131
Black walnut	4,913	--	--	--	--	--	--	--	--	4,622	291	--	--	--	--
Butternut	488	--	--	--	--	--	--	--	--	65	423	--	--	--	--
Yellow poplar	1,269	--	--	--	--	--	--	--	--	537	492	240	--	--	--
Other hardwoods	2,523	--	--	--	--	--	--	--	--	2,021	359	--	143	--	--
Total	1,672,806	16,781	8,996	12,516	49,354	3,775	3,311	44,148	645	409,335	242,184	107,887	725,030	48,342	502
All species	2,425,851	118,206	79,248	77,724	167,132	23,606	17,463	216,277	3,818	422,062	281,254	133,569	823,437	57,277	4,778

[1/] International 1/4-inch rule.

Table 14.--Average annual growing-stock removals on commercial forest land qualifying for harvest by forest type and stand-age class, Michigan, 1981-1990

(In thousand cubic feet)

Forest type	All classes	Stand-age class												
		1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-120	121-140	141+
Jack pine	40,493	--	--	--	--	16,465	12,264	5,002	4,500	1,465	497	189	111	--
Red pine	17,721	--	--	--	--	--	1,304	4,532	2,835	2,912	2,036	3,861	241	--
White pine	16,738	--	--	--	--	--	--	--	2,327	4,511	4,190	2,323	2,207	1,180
Balsam fir	54,572	--	--	--	--	14,230	12,637	8,968	6,555	3,696	2,410	3,912	1,504	660
White spruce	6,706	--	--	--	--	--	1,046	1,082	796	1,557	--	1,839	--	386
Black spruce	7,766	--	--	--	--	--	--	2,029	1,582	375	379	1,591	1,119	691
Northern white-cedar	81,946	--	--	--	--	--	--	--	9,948	18,354	13,624	19,473	10,857	9,690
Tamarack	2,047	--	--	--	--	--	627	523	342	167	388	--	--	--
Oak-hickory	93,139	--	--	--	--	--	--	10,429	25,611	18,245	11,445	22,812	4,257	340
Elm-ash-soft maple	69,642	--	--	--	--	--	--	8,539	13,369	14,925	8,197	14,974	7,153	2,485
Maple-birch	34,766	--	--	--	--	--	2,095	3,508	4,419	6,096	5,658	9,278	3,070	642
Aspen	240,031	--	--	--	26,391	68,535	58,979	34,956	25,096	11,661	7,515	6,898	--	--
Paper birch	22,605	--	--	--	--	3,457	13,101	3,992	1,123	--	647	285	--	--
Exotic	1,396	--	--	--	--	261	1,135	--	--	--	--	--	--	--
All types	689,568	--	--	--	26,391	102,948	103,188	83,560	98,503	83,964	56,986	87,435	30,519	16,074

Table 15.--Average annual growing-stock removals on commercial forest land qualifying for thinning by forest type and stand-age class, Michigan, 1981-1990

(In thousand cubic feet)

Forest type	All classes	Stand-age class												
		1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-120	121-140	141+
Jack pine	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Red pine	13,063	--	--	6,156	5,939	968	--	--	--	--	--	--	--	--
White pine	288	--	--	--	--	--	288	--	--	--	--	--	--	--
Balsam fir	--	--	--	--	--	--	--	--	--	--	--	--	--	--
White spruce	356	--	--	--	--	356	--	--	--	--	--	--	--	--
Black spruce	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Northern white-cedar	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Tamarack	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Oak-hickory	8,403	--	--	125	2,296	3,714	2,268	--	--	--	--	--	--	--
Elm-ash-soft maple	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Maple-birch	89,195	--	--	1,152	6,129	22,434	19,711	10,575	5,112	6,948	5,412	8,347	2,532	843
Aspen	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Paper birch	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Exotic	--	--	--	--	--	--	--	--	--	--	--	--	--	--
All types	111,305	--	--	7,433	14,364	27,472	22,267	10,575	5,112	6,948	5,412	8,347	2,532	843

Table 16.--Average annual growing-stock removals per acre on commercial forest land qualifying for harvest by forest type and stand-age class, Michigan, 1981-1990

(In cubic feet per acre)

Forest type	All classes	Stand-age class												
		1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-120	121-140	141+
Jack pine	1,201	--	--	--	--	1,236	1,146	1,305	1,295	1,002	1,132	816	447	--
Red pine	1,962	--	--	--	--	--	1,422	1,925	1,770	2,065	2,639	2,118	1,575	--
White pine	1,926	--	--	--	--	--	--	--	1,521	1,966	2,051	1,791	2,091	2,517
Balsam fir	1,578	--	--	--	--	1,747	1,381	1,572	1,554	1,643	1,864	1,661	1,547	1,361
White spruce	1,947	--	--	--	--	--	1,565	3,293	1,654	1,971	--	1,917	--	1,776
Black spruce	1,306	--	--	--	--	--	--	1,081	1,473	1,170	1,199	1,515	1,538	1,192
Northern white-cedar	1,671	--	--	--	--	--	--	--	1,566	1,564	1,831	1,664	1,741	1,738
Tamarack	917	--	--	--	--	--	708	899	1,048	1,109	1,346	--	--	--
Oak-hickory	1,702	--	--	--	--	--	--	1,595	1,751	1,548	1,591	1,925	1,787	1,008
Elm-ash-soft maple	1,634	--	--	--	--	--	--	1,559	1,500	1,752	1,820	1,632	1,557	1,743
Maple-birch	723	--	--	--	--	--	723	721	684	706	765	716	759	758
Aspen	1,710	--	--	--	1,528	1,581	1,743	1,959	1,975	1,671	1,469	2,130	--	--
Paper birch	1,759	--	--	--	--	1,826	1,772	1,615	2,034	--	1,669	1,885	--	--
Exotic	1,503	--	--	--	--	1,171	1,608	--	--	--	--	--	--	--
All types	1,545	--	--	--	1,528	1,538	1,536	1,611	1,581	1,491	1,532	1,540	1,495	1,618

Table 17.--Average annual growing-stock removals per acre on commercial forest land qualifying for thinning by forest type and stand-age class, Michigan, 1981-1990

(In cubic feet per acre)

Forest type	All classes	Stand-age class												
		1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-120	121-140	141+
Jack pine	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Red pine	1,074	--	--	933	1,370	785	--	--	--	--	--	--	--	--
White pine	1,153	--	--	--	--	--	1,153	--	--	--	--	--	--	--
Balsam fir	--	--	--	--	--	--	--	--	--	--	--	--	--	--
White spruce	803	--	--	--	--	803	--	--	--	--	--	--	--	--
Black spruce	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Northern white-cedar	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Tamarack	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Oak-hickory	594	--	--	302	526	608	695	--	--	--	--	--	--	--
Elm-ash-soft maple	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Maple-birch	634	--	--	555	626	618	629	677	611	627	606	694	584	926
Aspen	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Paper birch	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Exotic	--	--	--	--	--	--	--	--	--	--	--	--	--	--
All types	663	--	--	818	776	623	639	677	611	627	606	694	584	926

Smith, W. Brad; Spencer, John S., Jr.
Forest management opportunities for Michigan, 1981-1990. Res. Pap. NC-264. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1985. 31 p.

Uses a computer model to identify commercial forest that would benefit from forest management and the volume of removals that would result. Targets 63 percent of the State's commercial area for treatment—primarily harvest, stand conversion, and thinning.

KEY WORDS: Forest treatments, timber harvest, growing-stock volume, commercial forest land.

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